Environmental Remediation Group

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July 31, 2020

Ms. Lynne Jennings and Ms. Melanie Morash
U. S. Environmental Protection Agency (USEPA), Region 1
5 Post Office Square, Suite 100,
Mail Stop OSRR07-4, Boston, MA 02109-3912

RE: Operable Unit 1 & Operable Unit 2 Feasibility Study (Volume I)
Olin Chemical Superfund Site
51 Eames Street, Wilmington, MA

Dear Ms. Jennings and Ms. Morash:

The Operable Unit 1 and Operable Unit 2 (OU1/OU2) Feasibility Study (FS) for the Olin Chemical Superfund Site (OCSS) located at 51 Eames Street in Wilmington, Massachusetts is attached hereto. A draft OU1/OU2 FS, prepared in collaboration with the USEPA and the Massachusetts Department of Environmental Protection (MADEP), was previously submitted to USEPA on April 24, 2020. The attached version of the OU1/OU2 FS has been revised to incorporate USEPA and MADEP comments and subsequent discussions.

A separate FS, referred to as the Interim Action Feasibility Study (IAFS), is being prepared and will be submitted to the USEPA under separate cover. The IAFS is a companion document to this OU1/OU2 FS and will be referred to as Volume II. USEPA will complete the comparative analyses, which will be added to the OU1/OU2 and IAFS documents as Volume III.

We appreciate the input that you and your team provided during this significant effort and look forward to continuing to work together on this project. Please contact me at (423) 336-4012 if you have any questions.

Sincerely,
OLIN CORPORATION

James M. Cashwell
Director, Environmental Remediation

Enclosure:
Operable Unit 1 & Operable Unit 2 Feasibility Study (Volume I)

cc: Garry Waldeck (MassDEP)
Chinny Esakkiperumal (Olin)
Libby Bowen, Nelson Walter (Wood)

OLIN CHEMICAL SUPERFUND SITE
51 Eames Street
Wilmington, Massachusetts

Volume 1
Operable Unit 1 & Operable Unit 2
Feasibility Study

Prepared for:

United States Environmental Protection Agency
Region 1
5 Post Office Square, Suite 100
Boston, MA 02109

July 31, 2020

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LIST OF ACRONYMS

AMEC	AMEC Environment & Infrastructure, Inc.
Amec Foster Wheeler	Amec Foster Wheeler Environment & Infrastructure, Inc.
AOC	Administrative Order on Consent
ARAR	Applicable or Relevant and Appropriate Requirements
AWQC	Ambient Water Quality Criteria
AS	Air Sparging
BEHP	Bis(2-ethylhexyl)phthalate
BERA	Baseline Ecological Risk Assessment
bgs	below ground surface
BHHRA	Baseline Human Health Risk Assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	Chemical of Concern
CWA	Clean Water Act
cy	cubic yard
DAPL	Dense Aqueous Phase Liquid
EA	Exposure Area
EPH	Extractable Petroleum Hydrocarbon
ERH	Electrical Resistance Heating
facility	chemical manufacturing facility
floc	flocculent
FS	Feasibility Study
ft/day	feet per day
GAC	granular activated carbon
GERE	Grant of Environmental Restriction and Easement
gpm	gallons per minute
GPR	ground penetrating radar
HASP	Health and Safety Plan
HQ	Hazard Quotient

LIST OF ACRONYMS (cont.)

IC	Institutional Control
IAFS	Interim Action Feasibility Study
IRSWP	Interim Response Steps Work Plan
ISTT	In-situ Thermal Treatment
kW	kilowatt
LNAPL	Light Non-Aqueous Phase Liquid
MACTEC	MACTEC Engineering and Consulting, Inc.
MassDEP	Massachusetts Department of Environmental Protection
MCP	Massachusetts Contingency Plan
µg/L	microgram per liter
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mg/m^3	milligrams per cubic meter
NAULs	Notice of Activity and Use Limitations
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NDMA	N-nitrosodimethylamine
ng/L	nanogram per liter
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRWQC	National Recommended Water Quality Criteria
O&M	Operation and Maintenance
OCSS	Olin Chemical Superfund Site
OSWER	Office of Solid Waste and Emergency Response
off-PWD	off-Property West Ditch
Olin	Olin Corporation
on-PWD	on-Property West Ditch
OSHA	Occupational Safety and Health Administration
OU	Operable Unit
%	Percent
PAH	Poly Aromatic Hydrocarbon
PID	Photoionization Detector
ppm	parts per million
ppmv	parts per million by volume
PRB	Permeable Reactive Barrier

LIST OF ACRONYMS (cont.)

PRG	Preliminary Remediation Goal
Property	Olin Property, 51 Eames Street, Wilmington, MA
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RfD	Reference Dose
RI	Remedial Investigation
RME	Reasonable Maximum Exposure
RSL	Regional Screening Level
SASR	Semi-Annual Status Report
sf	square feet
SOW	Statement of Work
SSDS	Sub-Slab Depressurization System
SVE	Soil Vapor Extraction
THC	Thermal Conduction Heating
TMPs	Trimethylpentenes
TM1P	2,4,4-trimethyl-1-pentene
TM2P	2,4,4-trimethyl-2-pentene
TOC	Total Organic Carbon
USEPA	United States Environmental Protection Agency
UV	ultra violet
VI	Vapor Intrusion
VPH	Volatile Petroleum Hydrocarbon
Wood	Wood Environment & Infrastructure Solutions, Inc.

1.0 INTRODUCTION

This Feasibility Study (FS) has been prepared for Operable Unit (OU) 1 (soil, sediment, and surface water on the Olin Eames Street Property at 51 Eames Street in Wilmington MA [Property]) and OU2 (off-Property surface water and sediment areas) at the Olin Chemical Superfund Site (OCSS or Site) in Wilmington, MA (OU1/OU2 FS Report). The OU1/OU2 FS Report comprises the first of three volumes – Volume I – of the FS report for the Site. A second FS, the Interim Action FS (IAFS) Report (IAFS Report), has been prepared concurrently to evaluate remedial alternatives for source control and includes the Containment Area, light non-aqueous phase liquids (LNAPL) near Plant B, groundwater hot spots (i.e., areas of groundwater with the highest concentrations of Site-related contaminants), and dense aqueous phase liquids (DAPL) located above the bedrock surface in pools on and off the Site. The IAFS Report comprises Volume II of the FS report for the Site. The USEPA has prepared Volume III of the FS report, which provides the comparative analysis of the remedial alternatives presented in Volumes I and II.

The remedial alternatives developed in this FS report are also supported by two memoranda prepared by EPA, which update the conclusions and findings presented in the OU1/OU2 Remedial Investigation (RI) Report (AMEC Environment & Infrastructure, Inc. (AMEC), 2015; 2015 OU1/OU2 RI Report)[1] and Revised RI Report OU3 (Wood Environment & Infrastructure Solutions, June 2019; Draft 2019 OU3 RI Report).[2] Additional supporting documents for the FS report include memoranda documenting the development of Preliminary Remediation Goals (PRGs) for soil, sediments, and surface water[3] and the development of PRGs to address human

[1] Memorandum, *Olin Chemical Superfund Site, Updates to OU1/OU2 RI Report Conclusions, EPA, August 2020*.
[2] Memorandum, *Olin Chemical Superfund Site, Updates to OU3 RI Report Conclusions, EPA, August 2020*.
[3] Technical Memorandum, Documentation of Preliminary Remediation Goals (PRGs) for Soil, Sediment and Surface Water, Olin Chemical Superfund Site – Wilmington, MA, Olin Corporation, May 15, 2020.

health risks in DAPL, groundwater hot spots, upland soil (including Containment Area soil), and surface water.[4]

The OU1/OU2 FS Report addresses the United States Environmental Protection Agency (USEPA) comments on the previous draft OU1/OU2 FS report submitted to the USEPA on March 30, 2018 (Amec Foster Wheeler Environment & Infrastructure, Inc. [Amec Foster Wheeler], 2018a) and reflects the outcome of numerous subsequent meetings and correspondence between USEPA and Olin.

The OU1/OU2 FS Report was developed based on collaboration between Olin and the USEPA. This effort included several interim deliverables prepared by Olin and submitted to the USEPA for review. Comments provided by the USEPA were addressed and the revised interim deliverables were incorporated into this FS. These interim deliverables included, but were not limited to, brief descriptions of the alternatives, annotated outlines evaluating the proposed remedial alternatives, and submittal and review of the detailed analysis sections for each of the proposed remedial alternatives.

Consistent with the conclusions of the 2015 OU1/OU2 RI Report and more recent collaborative efforts between USEPA and Olin, this FS presents an evaluation of remedial alternatives that address:

- Potential inhalation risk to future indoor workers or occupants of future buildings associated with vapor intrusion (VI) of trimethylpentenes (TMPs) present in subsurface soil;
- Potential human health risks (ingestion and dermal contact) to trespassers in Off-Property West Ditch associated with benzo(a)pyrene present in surface water;
- Risk to ecological receptors associated with chromium and bis(2-ethylhexyl)phthalate (BEHP) in upland soils at specific areas within OU1 and OU2 (on-Property);

4 Technical Memorandum, Documentation of Preliminary Remediation Goals (PRGs) to Address Human Health Risks in Dense Aqueous-Phase Liquid (DAPL), Groundwater Hot Spots, Upland Soil (including Containment Area soil), and Surface Water at the Olin Chemical Superfund Site, Wood Environment & Infrastructure Solutions, Inc., July 1, 2020.

- Risk to ecological receptors associated with chromium and BEHP in wetland soils and aquatic sediments at specific areas within OU1 and OU2; and
- Risk to ecological receptors associated with chromium and ammonia that is present or could be present in the future in surface water of the South Ditch (OU1 and OU2) and East Ditch (OU2) as the result of the discharge of contaminated overburden groundwater to surface water.

(Note: In recent documents, USEPA refers to East Ditch and South Ditch as East Ditch Stream and South Ditch Stream (similar terminology has also been adopted for the other ditches at the Site). USEPA's preferred terminology is acknowledged. However, because historically and in past iterations of this report, these water bodies are referred to as "ditches," this term will continue to be used throughout this report. USEPA's preferred terminology will be used in subsequent communications where appropriate.

The Containment Area is considered part of OU1 and was included in the previous draft OU1/OU2 FS report (Amec Foster Wheeler, 2018a). However, based on USEPA comments and discussions between USEPA and Olin, the Containment Area is being addressed in the IAFS Report. Therefore, the Containment Area is not considered as part of the OU1/OU2 FS Report.

1.1 Purpose, Scope and Report Organization

1.1.1 Purpose and Scope

The purpose of this document is to develop and present an appropriate range of remedial alternatives to allow selection of a remedy that is consistent with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the National Contingency Plan (NCP) (40 Code of Federal Regulations [CFR] Part 300), the CERCLA Guidance for Complying with Other Laws (USEPA, 1988a), and the Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (Office of Solid Waste and Emergency Response [OSWER] Directive 9355.3-01) (USEPA, 1988b). The remedial alternatives presented in this document are developed by assembling combinations of technologies into alternatives that address contamination that presents potential risk in the OU1 and OU2 areas.

1.1.2 Report Organization

The remainder of Section 1 presents background information, a description and history of the OCSS, including past response actions, where applicable, and remedial investigations conducted under CERCLA. This is followed by a summary of the nature and extent of contamination, the fate and transport of chemicals of concern (COCs), and the conclusions of the Baseline Human Health Risk Assessment (BHHRA) and Baseline Ecological Risk Assessment (BERA).

Section 2 presents the Remedial Action Objectives (RAOs) and discusses Applicable or Relevant and Appropriate Requirements (ARARs), COCs, and the development of PRGs.

Section 3 presents the identification and screening of technologies. This section develops the general response actions to meet the RAOs and identifies technologies specific to each media to be remediated and screens those technologies for feasibility and implementability. Technologies that meet screening criteria are retained for development of alternatives.

Section 4 provides a detailed analysis of the retained remedial alternatives.

Section 5 provides a list of references pertinent to the OU1/OU2 FS Report.

1.2 Background Information

The OCSS is located at 51 Eames Street in Wilmington, Massachusetts (**Figure 1.2-1**). The OCSS includes the Olin Corporation (Olin) Property (Property), an approximately 50-acre parcel, and adjoining select off-Property areas impacted by historical manufacturing and waste disposal activities at the Property. A chemical manufacturing facility ("facility") was located within the northern portion of the Property (**Figure 1.2-2**).

Manufacturing activities were conducted at the OCSS from 1953 until 1986, when all manufacturing operations ceased. Olin purchased the Property in 1980 and operated the facility until 1986. From 1953 onward, the facility expanded incrementally, with buildings constructed as additional products and processes were added and processes were modified. The facility produced chemical products for use in the rubber and plastics industries. Additional information regarding the history of the OCSS, including Massachusetts Contingency Plan (MCP) and CERCLA response actions, is presented in the 2015 OU1/OU2 RI Report.

The OCSS was listed on the National Priorities List (NPL) pursuant to CERCLA Section 105, 42 U.S.C. § 9605 on April 19, 2006 (71 Federal Register 20,016). N-nitrosodimethylamine (NDMA) was the primary substance used by USEPA to score the OCSS (USEPA, 2005) in September 2005 when it was proposed for the NPL. The primary exposure pathway scored by USEPA was potable use of groundwater. Prior to the NPL listing, the OCSS was the subject of many years of investigation and response activities carried out by Olin and supervised by the Massachusetts Department of Environmental Protection (MassDEP) under Chapter 21E of the General Laws of Massachusetts and the MCP. The OCSS was listed as a priority disposal site under the MCP in

1993, and a Tier I site in 1994. However, the OCSS is no longer considered an MCP Tier I site and is now regulated by the USEPA.

Olin Corporation, American Biltrite Inc. (and The Biltrite Corporation), and Stepan Company, as Co-Respondents, voluntarily entered into an Administrative Settlement Agreement and Order on Consent (AOC) with the USEPA to conduct an RI/FS for the OCSS (USEPA, 2007a) on July 3, 2007. The scope of the RI/FS is described in the Statement of Work (SOW), prepared by the USEPA Region I – New England (USEPA, 2007b).

USEPA has subdivided the OCSS into three OUs, as defined in the AOC/SOW, and are described as follows.

OU1: Approximately 50-acre Olin Property including the former facility area, the established conservation area, the on-Property ditch system, the Calcium Sulfate Landfill, and the Slurry Wall Containment Area. The RI/FS, beginning in 2007, evaluated vadose-zone soil, surface water, sediment, and potential VI into OU1 buildings.

OU2: Off-Property surface water and sediment areas, including the off-Property East Ditch, a small portion of the South Ditch, the off-Property West Ditch (off-PWD), and portions of the Maple Meadow Brook Wetland. The North Pond and Landfill Brook were investigated as part of OU2 and were found not to be part of the OCSS (AMEC, 2015, and MACTEC Engineering and Consulting, Inc. [MACTEC], 2007).

OU3: On- and off-Property groundwater areas including groundwater beneath the Olin Property, Maple Meadow Brook aquifer, and groundwater located south and east of the Olin Property. A revised draft RI for OU3 groundwater was submitted to USEPA on June 28, 2019 (Wood, 2019a; Draft 2019 OU3 RI Report).

The OU1/OU2 FS Report identifies and evaluates remedial alternatives for OU1 soil, sediment, surface water, and potential VI into buildings that may be constructed in the future on the Property, and OU2 soil, sediment, and surface water. The IAFS Report addresses the Containment Area, LNAPL at Plant B, groundwater with elevated concentrations of NDMA (groundwater hot spots), and the presence of DAPL. A separate FS report will be prepared at a later date to address all OU3 groundwater.

1.3 Site Description

The OCSS encompasses the Property and surrounding areas where Site-related contaminants have migrated by surface water, sediment, and/or groundwater transport. The Property is bounded on the east by the Massachusetts Bay Transit Authority tracks, on the south by the Woburn/Wilmington Town Line, on the west by an inactive Boston and Maine Railroad spur, and on the north by Eames Street (see **Figure 1.2-2**). The Property is in an industrialized area of Wilmington within a general industrial zone. Intensive industrial land use occurs on the eastern, northern and western sides of the Property. The southern side of the Property is bounded by the Woburn Sanitary Landfill, a former municipal solid waste landfill that has been closed. Residential properties are located along Main Street and Cook Avenue located to the west of the Property and along Eames Street before it intersects with Woburn Street. These current and historical Site features are shown on **Figure 1.3-1**. Additional information about the Olin Property is presented in the 2015 OU1/OU2 RI Report and the revised Draft 2019 OU3 RI Report.

The former manufacturing facility was located on the northern half of the Property, which is currently unused and contains a vacated office building, a small metal butler building, a former guard shack, two vacant warehouses, paved and grassed areas, and concrete slabs from other former buildings (see **Figure 1.3-1**). In 2006, for Site maintenance and management purposes, Olin installed a forty-foot office trailer and two metal storage trailers in the northeastern portion of the Property, near the Plant B extraction and treatment system.

OU1 and OU2 contain on-Property and off-Property surface water bodies, respectively (see **Figure 1.2.-2 and Figure 1.3-1**). The on-Property surface water includes a ditch system of natural drainage that was modified in the early 1950s (the on-Property West Ditch [on-PWD] and the South Ditch) and a natural wetland drainage complex (Ephemeral Drainage) (AMEC, 2015). A surface water body, known as the Central Pond, and a large wetland area known as the Central Wetland, are located north of, and adjacent to, the Lower South Ditch. Central Pond does not discharge to South Ditch. A stormwater retention basin is present between the Containment Area and South Ditch. The on-Property ditch system is connected to two other off-Property ditches (off-PWD and the East Ditch). These drainages are all part of the Aberjona River watershed. Other surface water bodies within the study area include Maple Meadow Brook, Sawmill Brook, and the associated Maple Meadow Brook Wetland to the west, which are part of the Ipswich watershed. These two watersheds are separated by a groundwater divide, which corresponds approximately with a portion of Eames Street, then southward parallel to Main Street.

The Plant B extraction and treatment system has been in operation since 1981. The system was installed in response to the seepage of a LNAPL into the East Ditch that is located at the eastern perimeter of the Property. The LNAPL is a processing oil that contains BEHP, NDMA and TMPs. The system was designed to create a groundwater cone of depression to prevent migration of the LNAPL and allow for mechanical LNAPL removal. Capture and treatment of dissolved constituents in groundwater is incidental to this objective. The current system includes three extraction wells operating at a combined rate of less than 10 gallons per minute (gpm). Groundwater extracted during operation of the system is pre-treated with granular activated carbon (GAC) to remove iron as well as dissolved organic compounds and then ammonia by break point chlorination by sodium hypochlorite addition. After ammonia removal, the water is polished through a second GAC bed followed by an ion exchange media that was added to remove arsenic. The treated groundwater is discharged to South Ditch (discharge location shown on Figure 1.3-1 of the 2015 OU1/OU2 RI Report) on the Property in compliance with a remediation general permit.

South Ditch begins at the western boundary of the Property and flows east across the center of the Property, discharging into East Ditch. South Ditch is a surface water feature that receives surface flow from the off-PWD and on-PWD, as well as discharge from overburden groundwater. The flow varies, but the water depth in South Ditch is typically approximately six inches. South Ditch is a gaining stream during seasonal high groundwater conditions and a losing stream in drier months. The middle of South Ditch commonly goes dry during these periods.

In support of the BHHRA and BERA assessments, Exposure Areas (EAs) were established to facilitate evaluation of potential risks to receptors. The BHHRA and BERA EAs are shown on **Figure 1.3-2 and Figure 1.3-3**, respectively. In subsequent sections of this report, these EAs are referred to as HH-EAx (human health) and E-EAx (ecological), respectively (the "x" in the nomenclature refers to the exposure area number).

1.4 Nature and Extent of Contamination

The nature and extent of contamination across OU1 and OU2 are discussed in detail in the 2015 OU1/OU2 RI Report and are summarized in the following subsections.

The 2015 OU1/OU2 RI Report concludes with a recommendation that the scope of the OU1/OU2 FS should address potential ecological risk for surface water and sediment in the South Ditch and soil in E-EA5 located adjacent to the off-Property portion of the South Ditch. EA5 is physically located between the eastern Property boundary and the East Ditch encompassing both sides of Lower South Ditch. South Ditch surface water is impacted by chromium and ammonia; South Ditch sediment and off-Property soil in this area are impacted by chromium and BEHP.

The Screening Level Ecological Risk Assessment included in the 2015 OU1/OU2 RI Report concluded that no further evaluation of the East Ditch was warranted due to poor quality habitat and virtually no functional wetland value. USEPA raised concerns that TMPs and BEHP in groundwater in the area of Plant B could potentially impact the ecological quality of East Ditch should Plant B cease operation, and remedial alternatives associated with potential groundwater discharge from the Plant B area to the East Ditch have been included in the OU1/OU2 FS Report. The potential for Plant B groundwater to have an impact on East Ditch surface water is discussed in Section 1.4.5. The results of the BHHRA are discussed in Section 1.6.

The 2015 OU1/OU2 RI Report also recommended that potential VI of TMPs from subsurface soil into future buildings at HH-EA7, HH-EA3, and the former Lake Poly Area in HH-EA1 (potential indoor worker exposure) and potential inhalation exposure during future excavation of soils (construction worker exposure) be controlled. Remedial alternatives to address potential exposure to indoor workers and building occupants are evaluated in this FS. HH-EA7 is physically located in the northeast corner of the Property and encompasses the parking lot adjacent to the former administration building and the former Plant B production area. HH-EA3 encompasses the former Plant B tank farm which is the current location of the Plant B groundwater extraction and treatment system. Lake Poly was one of the former unlined lagoons located on the western side of HH-EA1.

The following sections summarize the nature and extent of contamination and fate and transport for the specific media and contaminants that are being addressed by this FS.

1.4.1 TMPs in OU1 Soil

Volatile organic compounds were not frequently detected in soil samples collected within OU1 with the exception of TMPs, which were detected in soil samples collected from areas in the vicinity of the former Plant B and the area to the northeast (HH-EA7), the former Plant B tank farm (HH-EA3), and the former Lake Poly within HH-EA1. TMPs were also detected at several locations within the Containment Area, which is not further evaluated in the OU1/OU2 FS Report. Remedial alternatives for the Containment Area soils are presented in the IAFS Report.

The distributions of total TMP concentrations in shallow (0-1 foot) and deeper subsurface soils (1-10 feet) are presented on **Figure 1.4-1 and Figure 1.4-2,** respectively. During development of the 2015 OU1/OU2 RI Report, there were no USEPA-published vapor intrusion screening values or USEPA-published toxicity values for TMPs. Therefore, a surrogate Industrial Soil Direct Contact RSL was calculated to assist with risk assessment. This surrogate value, 39 milligrams per kilogram (mg/kg), was presented in the 2015 OU1/OU2 RI Report and is used in **Figures 1.4-1 and 1.4-2** of this report to identify areas where TMPs were most frequently detected, and to define areas where TMP remedies are considered in this FS. Representations using 39 mg/kg in this FS have been developed for feasibility comparisons only. The full extent of areas where a TMP remedy is required will be determined based on pre-design investigations.

TMPs were detected in soil from HH-EA7, HH-EA3, and HH-EA1 (former Lake Poly area) at concentrations ranging from non-detect to 1,510 mg/kg. Soil sample photoionization detector (PID) screening, documented in the soil boring logs, indicated substantial TMP vapors (up to 3,000 parts per million [ppm]) were associated with samples collected at and near the water table in HH-EA7 and HH-EA3. These observations and the high vapor pressure of TMPs form the technical basis for identifying vapor intrusion potential for future buildings in areas where the TMPs are detected.

1.4.2 Chromium and BEHP in OU1 Upland Soil

Chromium and BEHP were detected at concentrations above ecological risk-based PRGs in on-Property surface and subsurface upland soils in several areas, including E-EA1, E-EA3, and E-EA4. The distributions of chromium and BEHP relative to the applicable PRGs in upland surface soils (0-1 feet below ground surface [bgs]) and shallow subsurface soils (1-10 feet bgs) samples are summarized on **Figures 1.4-3 and 1.4-4,** respectively. For reference, figures 4.1-5 through 4.1-7 and 4.1-17 through 4.1-19 of the 2015 OU1/OU2 RI Report presented the specific chromium and BEHP concentrations per sampling location in all Site soil samples. Concentrations of chromium and BEHP in soil samples above PRGs of 1,000 mg/kg and 3 mg/kg, respectively, were used to delineate areas in upland soils for which remedial alternatives are evaluated. The concentrations above the respective PRGs were considered to be of potential concern for the American Robin food chain exposures for upland soils.

1.4.3 Chromium and BEHP in OU1 and OU2 Wetland Soil and Sediments

Because potential remedial technologies and alternatives are similar for chromium and BEHP in wetland soils and sediments, the identification and evaluation of remedial alternatives for these media have been conducted concurrently. Wetland soils addressed in this FS include specific areas within E-EA4 in OU1 and E-EA5 in OU2. This FS addresses sediment of the Off-Property West Ditch, Upper and Lower South Ditch, and Central Pond. The nature and extent of chromium and BEHP contamination for these media is discussed below.

1.4.4 Wetland Soil

Chromium and BEHP were detected at concentrations above background in on-Property surface and subsurface soils, in wetland areas of the Property, and above ecological risk-based PRGs identified for E-EA5 soils areas including E-EA4 and E-EA5. Chromium and BEHP concentrations in soil samples above 600 and 20 mg/kg, respectively, were used to delineate areas in wetland soils for which remedial alternatives are evaluated. The distributions of chromium and BEHP concentrations in relation to their respective RPGs in wetland surface (0-1 feet bgs) and shallow subsurface (1-10 feet bgs) soil samples are summarized on **Figures 1.4-5 and 1.4-6,** respectively. As indicated above, chromium and BEHP concentrations were presented on various figures included in the 2015 OU1/OU2 RI Report. The concentrations above the PRGs discussed above were considered to be of potential concern for the Marsh Wren food chain exposures for wetland soils.

OU2 wetland soil data collected from the floodplain of the off-Property portion of South Ditch (EA5) include historical (pre-OU1/OU2 RI) samples and samples collected during the OU1/OU2 RI. Impacts to wetland soils in EA5, particularly from chromium and BEHP, are of concern due to potential risk to ecological receptors. The existing impacts to EA5 soil are believed to be associated with direct historical discharges to the ditch system during facility operation, and in the case of chromium, is likely associated with subsequent flooding and deposition. Chromium concentrations in EA5 wetland soil range from 9 to 62,000 mg/kg. The chromium PRG for wetland soils is 600 mg/kg. Hexavalent chromium was not identified as a COC in surface water, sediment, or soil within OU1 and OU2 as documented in the Technical Memorandum Hexavalent Chromium in Groundwater, Surface Water, Sediment, and Soil at the Olin Chemical Superfund Site (Wood, 2020a). The BEHP concentrations in EA5 soil ranged from 0.02 mg/kg to 216 mg/kg. The BEHP PRG for wetland soil is 20 mg/kg. The distribution of BEHP and chromium in EA5 soil is presented on **Figure 1.4-5 and 1.4-6**.

Groundwater discharge does not appear to be a source of BEHP in South Ditch and the associated wetland soils. BEHP was not detected in shallow overburden groundwater discharging to South Ditch. Results of the OU1/OU2 RI indicated that BEHP in South Ditch was only detected at ISCO-2 (1.6 micrograms per liter [µg/L]), which is located within the footprint of impacted South Ditch sediments within EA5 and is close to the confluence of East Ditch and South Ditch. Other upstream surface water locations in South Ditch did not have detectable BEHP. The historical source of BEHP is believed to have been overflow discharge from Lake Poly to the former on-PWD, which flowed into South Ditch. The ongoing surface water and groundwater sampling program has been modified to include more robust sampling in and adjacent to these surface water bodies to confirm that groundwater is not acting as a source of BEHP to the South Ditch.

1.4.4.1 Sediment

OU1/OU2 sediment data collected from water bodies at the Site include historical investigation samples, excavation confirmatory samples, OU1/OU2 RI samples, and annual sediment samples collected during Interim Response Steps Work Plan (IRSWP) activities (MACTEC 2008). This FS addresses remedial alternatives for sediment of the South Ditch, off-Property West Ditch (off-PWD), and Central Pond. The current impacts to Lower South Ditch sediment are believed to be primarily associated with historical releases to the ditch system. Sediments of the South Ditch, off-PWD, and Central Pond are of concern due to potential risk to ecological receptors. Sediments in these locations were identified for evaluation based on chromium and BEHP concentrations above the ecological risk-based PRGs of 100 mg/kg for both chromium and BEHP.

<u>South Ditch Sediment</u>

The Upper South Ditch sediments were previously excavated and disposed of off-site. Many soil samples have been collected either from the banks of the South Ditch (entire length of the ditch) or from the sidewalls or bottom of the excavations during the 2000 remediation of sediments of the Upper South Ditch**.** In consideration of concern for potential release of chromium and BEHP from the soils on the bank or sidewalls or bottom of excavations into the ditches or even erosion of the bank soils into the ditch, in this FS, all soil samples collected from locations between tops of the banks of the South Ditch have been treated as aquatic sediments and are evaluated using aquatic sediment PRGs (100 mg/kg for both chromium and BEHP). Throughout the remainder of this FS, reference to sediment of the South Ditch is intended to include both aquatic sediments and those soils immediately adjacent to (within the banks) the South Ditch.

The distribution of chromium and BEHP concentrations in sediments in relation to their respective PRGs for all samples collected to date is presented and summarized on **Figure 1.4-5.** The chromium concentrations in sediment samples collected during the OU1/OU2 RI from the Lower South Ditch range from 773 to 3,000 mg/kg, while concentrations in the remediated Upper South Ditch range from 32 to 273 mg/kg. For reference, the 2015 OU1/OU2 RI Report previously presented the chromium and BEHP concentrations per location in OU1/OU2 RI sediment samples in Figures 4.1-42 and 4.1-46, respectively.

Concentrations of BEHP in OU1/OU2 RI samples range from 210 to 480 mg/kg in the un-remediated Lower South Ditch while BEHP concentrations in sediment samples from the remediated Upper South Ditch range from 0.27 to 0.72 mg/kg. Interim Response Steps Work

Plan (IRSWP) average chromium concentrations at each Upper South Ditch sediment sampling location are lower than concentrations in the Lower South Ditch. However, IRSWP average chromium concentrations in all but one South Ditch sampling location (SD-3), and all OU1/OU2 RI sediment samples from the South Ditch were equal to or greater than the ecological risk-based PRG of 100 mg/kg.

Annual sediment samples are collected along South Ditch under the previously approved IRSWP. These samples are analyzed for iron, aluminum, and chromium, which are the primary components of the inert flocculent (floc) that is observed periodically in South Ditch surface water. Results from these annual sediment samples are reported in the Semi-Annual Status Reports (SASRs). Chromium data from sediment samples are useful to evaluate potential recontamination of South Ditch sediments by discharge of chromium-containing groundwater into the South Ditch. **Figure 1.4-7** presents trend charts for chromium sediment concentrations in the South Ditch based on annual sampling from 2010 through 2019.

Chromium concentrations in IRSWP sediment samples from SD-SD1 (wetland area in E-EA2) and SD-SD4 (Central Pond) have been remained low (maximum concentration of 67 mg/kg) since 2012. In the period 2016 to 2018, chromium concentrations in sediment samples from locations SD-SD2, SD-SD3, and SD-SD5 were substantially higher than in previous sampling rounds. Chromium concentrations returned to low levels (83 mg/kg and 40 mg/kg, respectively) at locations SD-SD2 and SD-SD3 in 2019. The chromium concentration at SD-SD5 remained elevated (3800 mg/kg) in 2019. Given the continuing formation of iron/aluminum/chromium floc in the South Ditch, it is possible that floc may have been collected along with sediment samples in the 2016 to 2018 period and it may also be possible that floc had been incorporated into sediment samples at locations SD-SD2, SD-SD3, and SD-SD5. A future pre-design investigation will assess the distribution of chromium in sediments of the entire South Ditch prior to any remedial actions for the ditch sediments.

Current data indicate that the former sediment excavation remedy in Upper South Ditch was successful for BEHP since BEHP concentrations in the Upper South Ditch are below the BEHP sediment PRG of 100 mg/kg. BEHP concentrations in the Lower South Ditch sediments where no remediation has been performed are above the PRG. BEHP has very low water solubility, approximately 3 µg/L, (European Chemicals Agency, 2020) and the shallow groundwater data from monitoring wells in the area of South Ditch indicate that groundwater is a not an on-going source of BEHP to sediments.

The iron/aluminum/chromium floc is a precipitate that results from the discharge of groundwater into the more buffered (higher pH) surface water downstream of the weir. The floc has been studied extensively, is reported to be thermodynamically stable under the neutral oxidizing conditions of the stream environment, and it is unlikely to represent an ecological risk due to its low solubility and bioavailability (Geomega, 2004).

Off-PWD Sediment

The off-PWD is located outside the western boundary of the Property. Off-PWD sediment analytical data collected during the OU1/OU2 RI are summarized in Table 4.2-7 of the 2015 OU1/OU2 RI Report (AMEC, 2015). Chromium was detected in three samples collected from the off-PWD at concentrations ranging from 250 to 2,400 mg/kg as shown on Figure 4.1-42 of the 2015 OU1/OU2 RI Report. BEHP was detected in three samples collected from the off-PWD at concentrations ranging from 0.047 to 0.12 mg/kg as shown on Figure 4.1-46 of the 2015 OU1/OU2 RI Report. These sample locations are also shown on the attached **Figure 1.4-5** which include OU1/OU2 RI sampling locations in addition to samples collected during previous investigations.

The highest concentrations of calcium, chromium, iron, manganese, sodium, and zinc occurred at OPWD-SD-S, which is the downstream sample location prior to water turning south and flowing under the PanAM railway to South Ditch. The elevated iron and chromium may suggest the presence of small amounts of floc which was noted in one surface water sampling event.

Central Pond Sediment

Central Pond is a shallow pond located north of South Ditch. The pond is generally round in shape and approximately 100 feet in diameter. There is no surface water connection to the South Ditch or other ditches at the Property. The water in the pond is typically several feet below the land surface. The nearby wells are water table wells (screened across the water table) and the elevations of both the pond and the water table appear to be the same. There is no indication geologically of silty material in the stratigraphy, and the pond sediments were excavated previously to underlying soil (sandy unconsolidated deposits). Therefore, by all indications, the underlying aquifer is expected to be unconfined indicating that Central Pond is an expression of the shallow groundwater water table.

Five sediment samples were collected from the Central Pond during the OU1/OU2 RI. The resulting data are summarized in Table 4.1-9 of the 2015 OU1/OU2 RI Report. Chromium was detected in all five samples, at concentrations ranging from 15 to 140 mg/kg as shown on Figure 4.1-42 of the 2015 OU1/OU2 RI Report. BEHP was not detected in any of the OU1/OU2 RI sediment samples as shown on Figure 4.1-46 of the 2015 OU1/OU2 RI Report.

Potential BEHP Groundwater/Sediment and Groundwater/Wetland Soil Interaction

A thorough review of available Site groundwater, surface water, and sediment data was conducted to evaluate the possibility that shallow groundwater adjacent to the South Ditch might contain BEHP and contaminate these media.

Figure 4.4.5-1a of the Draft 2019 OU3 RI Report summarizes the laboratory results for BEHP in shallow groundwater at the Site including the areas adjacent to the South Ditch. There are only sporadic detections of BEHP in shallow groundwater across the Site. There are no BEHP detections in the shallow monitoring wells located closest to the South Ditch (GW-50S, GW-56S, GW-79S, GW-55S, and GW-202S) with laboratory reporting limits of 1.8 µg/L. The monitoring well with detected BEHP that is closest to the South Ditch is GW-17S, with one detection at an estimated concentration of 1.2µg/L and a non-detect with a reporting limit of 1.8 µg/L. Monitoring well GW-17S and monitoring well GW-14 (BEHP at an estimated concentration of 0.6 µg/L) are the only monitoring wells between the only groundwater source area for BEHP (Plant B) at the Site and the South Ditch. BEHP was not detected in 13 other shallow monitoring wells located between the Plant B source area and the South Ditch. Well GW-17S is approximately 300 feet north of the South Ditch and well GW-14 is located approximately 1,000 feet north of the South Ditch.

BEHP was detected in only two of 11 South Ditch surface water samples collected during the OU1/OU2 RI. The detected concentrations were 1.8 µg/L and 6.1 µg/L. These two detections were higher than the only two detections of BEHP in groundwater samples collected from the area of the South Ditch. This is a line of evidence for the conclusion that groundwater discharge to surface water is not impacting surface water.

Prior to the remediation of sediments of the Upper South Ditch in 2000, BEHP concentrations in sediments of the South Ditch were reasonably uniform within the Upper South Ditch and Lower South Ditch. A review of the BEHP sediment data from the OU1/OU2 RI (figures and data evaluation provided in the 2015 OU1/OU2 RI Report) indicates that BEHP concentrations in sediments of the Upper South Ditch (0.49, 0.27, and 0.72 mg/kg) are substantially lower than the corresponding concentrations in the Lower South Ditch (210, 280, and 480 mg/kg). These data indicate that the remediation of the Upper South Ditch sediments reduced concentrations by at least two orders of magnitude and the concentrations remain very low 20 years after the remediation. This finding is consistent with the conceptual site model presented in the 2015 OU1/OU2 RI Report that the South Ditch sediments were historically contaminated primarily with chromium and BEHP as the result of overflow of the liquid waste stream from Lake Poly and other waste disposal features. This overland flow discharged to the on-Property West Ditch and subsequently flowed into the South Ditch where the chromium and BEHP were deposited on sediments and were absorbed to sediments. Chromium and BEHP also deposited on E-EA5 surface soils during flooding events. The OU1/OU2 RI data for BEHP in sediments do not suggest any ongoing groundwater BEHP impacts to sediments of the South Ditch.

It was not necessary to identify an ecological risk-based surface water PRG for BEHP because BEHP has such low water solubility and there is not documented toxicity to aquatic life at the solubility limit of BEHP. BEHP is not included in the analyte list for the quarterly IRSWP sampling of groundwater and surface water of the South Ditch nor was it included in the 2019 comprehensive groundwater sampling event because historical sampling and analysis did not indicate that BEHP was a concern for human health or ecological receptors for those media. The 2015 OU1/OU2 RI Report and the Draft 2019 OU3 RI Report further support that conclusion based on the historical data.

1.4.5 OU1 Surface Water – South Ditch

Surface water impacts (especially from ammonia and chromium) are of concern due to potential risks to ecological receptors. OU1/OU2 surface water samples collected from the South Ditch include historical samples collected per the RI/FS Work Plan and quarterly samples collected under the IRSWP. Quarterly groundwater samples are also collected under the IRSWP and reported to the USEPA in the SASRs. The quarterly groundwater samples are analyzed for ammonia, chloride, sulfate, and specific conductance, and filtered groundwater samples are analyzed for aluminum and chromium. These data show a consistent identification of constituents and ranges of concentrations detected in the surface water samples along the entire reach of South Ditch. The headwaters of South Ditch include the off-PWD and storm run-off catchments in the immediate vicinity of Jewel Drive. The available hydrogeologic information, groundwater data, groundwater elevation measurements in the surrounding well pairs and piezometers, and surface water data indicate that constituents in surface water of the South Ditch are primarily related to constituents present in groundwater underlying the Upper South Ditch and shallow groundwater migrating to the ditch. Trend plots for upper and lower South Ditch surface water including concentrations of chromium and ammonia are presented on **Figures 1.4-8 and 1.4-9**, respectively.

Chromium was detected in South Ditch surface water during the OU1/OU2 RI (2010-2011) at concentrations ranging from 0.012 to 2.2 milligrams per liter (mg/L). Chromium concentrations have declined by an order of magnitude over time, with chromium concentrations from samples collected in December 2018 (SASR No. 24, Wood, 2019b) ranging from non-detect (<0.001 mg/L) to 0.04 mg/L. Maximum dissolved chromium concentrations since December 2018, including samples from August 2019 (SASR No. 25, Wood 2020b) have been below 0.10 mg/L which is the site-specific, hardness-dependent chromium ambient water quality criterion (Wood, 2020c).

Ammonia was detected in South Ditch surface water during the OU1/OU2 RI (2010-2011) at concentrations ranging from 21 to 130 mg/L. Overall, ammonia concentrations have declined substantially over time with ammonia concentrations from samples collected in December 2018 as reported in SASR No. 24 (Wood, 2019b) ranging from 1.2 to 14 mg/L. However, concentrations in the South Ditch continue to fluctuate with the ammonia concentrations from Upper South Ditch and Lower South Ditch samples collected in spring 2019 as reported in SASR No. 25 (Wood, 2020b) above the site-specific ambient water quality criterion of 15 mg/L (Wood, 2019d). Since January 2017 ammonia concentrations in quarterly surface water samples from Upper South Ditch have ranged from 7.1 to 190 mg/L, with all but two concentrations being less than or equal to 44 mg/L). Ammonia concentrations in Lower South Ditch have ranged from 9.3 to 73 mg/L with all but two concentrations being less than or equal to 41 mg/L.

The concentration of chromium and ammonia have declined relative to values that were present at the time the OU1/OU2 RI and associated ecological risk assessment were competed. At the time the OU1/OU2 RI was completed, the long-term changes in concentrations for chromium and ammonia, as well as other DAPL-related solutes in South Ditch, were concluded to be a result of groundwater discharge. Evidence suggested that groundwater was the source of these contaminants, but the underlying sources, particularly the changes in contaminant concentrations, were not well understood. A detailed review of available groundwater data and its relationship to sources of contamination in surface water concluded the following:

- Pumping of Sanmina industrial water supply wells across Jewel Drive previously drew contaminated shallow and deep groundwater from above the off-PWD DAPL pool and the western edge of the on-Property DAPL pool. Construction of the Containment Area Slurry Wall in December 2000 greatly reduced the flux of contamination that could be drawn upgradient to the Sanmina wells.
- From 2001 to 2004, prior to Sanmina closing (September 2004), reductions in Sanmina well pumping rates resulted in increases in concentrations in shallow and deep overburden groundwater impinging on Upper South Ditch.
- After the closure of Sanmina, contaminated groundwater that was previously drawn upgradient by Sanmina, flowed by ambient gradients back toward South Ditch where it ultimately discharged causing a peak in both groundwater and surface water concentrations from 2005 to 2008/2009.

- Groundwater and surface water concentrations of chromium and ammonia (as well as other DAPL constituents) have continued to decline since 2008/2009 as a result of shutdown of the Sanmina wells, and the lowering of the off-PWD DAPL/diffuse groundwater interface from on-going DAPL extraction efforts. However, ammonia concentrations in surface water of the South Ditch are not yet consistently below the site-specific ambient water quality criterion of 15 mg/L.
- Ammonia and sulfate concentrations in groundwater have decreased at locations upgradient of GW-202S/D and PZ-16R (GW-24 and GW-25, respectively).
- The highest concentrations of ammonia and sulfate in groundwater are consistently detected at GW-202D and PZ-16R, which continue to show higher concentrations of these two COCs. Concentrations of ammonia and sulfate are also elevated at wells east of the Containment Area and further downgradient.
- Elevated contaminant concentrations are believed to be associated with the DAPL pools or other sources. Removal of DAPL is expected to reduce contaminant concentrations in groundwater and help mitigate impacts to the South Ditch surface water.

1.4.6 OU2 Surface Water – East Ditch

Surface water was evaluated in East Ditch under the OU1/OU2 RI program and as part of the Draft 2019 OU3 RI Report. Results for surface water samples collected in East Ditch immediately downstream from Plant B included non-detects and/or low concentrations of NDMA (6.3 to 12 nanograms per Liter [ng/L]), ammonia (0.26 to 0.92 mg/L), TMPs [2,4,4-trimethyl-1-pentene (TM1P) (3.9 to 4.4 μg/L), 2,4,4-trimethyl-2-pentene (TM2P) (not detected to 0.57 μg/L)], and BEHP (not detected to 1.5 μg/L). Based on interpreted potentiometric surfaces presented in the Draft 2019 OU3 RI Report, during operation of the Plant B groundwater extraction and treatment system, groundwater flows toward East Ditch then along the axis of East Ditch. Given the low observed surface water flows in East Ditch, the ditch likely only captures a limited amount of the shallow groundwater flow. In addition, wells along the eastern side of East Ditch and north of the confluence with South Ditch (GW-403D and GW-402D) do not show impact from the OCSS, which suggests that groundwater is not flowing under East Ditch to the east in this portion of the Site. Farther south the groundwater leaving the South Ditch area passes under East Ditch

An additional ecological risk screening was conducted for a future scenario in which the Plant B groundwater extraction and treatment system is no longer operating and some groundwater from the area would be discharging to the East Ditch (Nobis 2019). In addition, a technical memorandum entitled *Response to Memorandum – "Olin Plant B/East Ditch Risk Evaluation V2" Dated August 27, 2019 and prepared by Nobis Group* (Wood, 2019c) clarifying the results of previous ecological risk assessments was submitted to USEPA on December 2019. Since surface water quality in the East Ditch is unknown for the future scenario where the Plant B extraction and treatment system is no longer operating, concentrations of chemicals detected in groundwater in the vicinity of Plant B were compared to ecological screening criteria from several sources. This conservative approach assumes no dilution of detected parameters in the groundwater as it flows toward the East Ditch and no dilution as the groundwater discharges to the surface water of the East Ditch. Concentrations of most parameters detected in groundwater samples were below ecological screening levels. Some concentrations of BEHP, ammonia, iron, and TMPs were above one or more available screening levels. Olin has committed to continued groundwater extraction and treatment in the Plant B area. Extraction of groundwater from the Plant B area is expected to continue to prevent unacceptable impacts related to potential groundwater discharge to the East Ditch.

1.5 Contaminant Fate and Transport

For current conditions within OU1 and OU2, there are few complete migration pathways. There is no evidence of erosional transport of impacted soils due to storm water runoff. Most of the land surface is well grassed and paved. Fate and transport considerations for the COCs are discussed in the following text. COCs for soils include TMPs, chromium, and BEHP. COCs for surface water include ammonia and chromium, and for sediment COCs include chromium and BEHP. The distribution of COCs in environmental media at OU1 and OU2 is consistent with the physical/chemical characteristics and fate and transport characteristics of those chemicals. BEHP, chromium, and TMPs are not highly water soluble and tend to be retained in soils and sediments. Ammonia is highly water soluble and is therefore highly mobile.

1.5.1 TMPs

TMPs are highly volatile and have high Henry's Law constants, indicating that TMPs present in subsurface soils represent a potential vapor intrusion pathway. **Figures 1.4-1 and 1.4-2** identify the distribution of TMPs in shallow subsurface and deep subsurface soils, respectively. TMPs were only sporadically detected in surface soils. TMP concentrations are highest in the water table capillary zone where they volatilize in vadose zone and may migrate vertically as vapor by diffusion and advection in response to changes in atmospheric pressure gradients. There are currently no occupied structures in contact with ground surface at areas where TMPs have been reported in subsurface soils. Therefore, there is no current VI pathway. However, if buildings were to be constructed and occupied in areas where TMPs have been identified in soil (HH-EA1, HH-EA3, and HH-EA7), a VI pathway could exist. Additionally, limited soil sampling was conducted throughout the main operations area of the Site (HH-EA1) due to obstructions related to remaining buildings and concrete foundations, raising the possibility that elevated levels of TMPs may be present in these areas. The limited characterization of soil beneath the remaining facility buildings and foundations introduces the possibility that contaminants such as TMPs could be present at sufficient concentrations elsewhere on the Site to result in unacceptable exposures should buildings be constructed and occupied in areas where elevated levels of TMPs are present, which could result in an unacceptable vapor intrusion risk.

TMPs are minimally soluble in water. Detections of TMPs in groundwater are primarily confined to the area of the former Plant B tank farm and the current Plant B groundwater extraction and treatment system and a small area immediately west of the Containment Area. Figures 4.4.3-2a through 4.4.3-3c of the Draft 2019 OU3 RI Report show TMP distribution in shallow and deep overburden and bedrock groundwater for TM1P and TM2P. There is no migrating TMP groundwater plume from those areas and there is no evidence of any other plume or localized area of groundwater with TMP detections (none near the South Ditch in particular). Therefore, migration of TMPs in groundwater and subsequent discharge to surface water is not a migration pathway of concern. Because of its low water solubility, leaching of residual TMPs from subsurface soil to groundwater is not of concern. The impact on groundwater in the Plant B area is associated with release of materials that formed an LNAPL at the water table, and the TMPs in groundwater are associated with that LNAPL. The Plant B groundwater extraction and treatment system was constructed to control migration of LNAPL to the East Ditch. The system is effective in doing so, and there has been only sporadic, trace concentrations of TMPs detected in the East Ditch surface water.

1.5.2 Chromium

Chromium is present in soils at the Site primarily in the trivalent form as discussed in Attachment 7 (*Chromium Evaluation*) to the OU1/OU2 BHHRA (Appendix M of the OU1/OU2 RI Report; AMEC, 2015) and in the Technical Memorandum *Hexavalent Chromium in Groundwater, Surface Water, Sediment, and Soil at the Olin Chemical Superfund Site* (Wood, 2020a). Trivalent chromium in soil is virtually insoluble in water under typical environmental conditions (precipitation, ambient surface water, and ambient groundwater). Therefore, trivalent chromium in soils at the Site is not of concern with respect to leaching from soils on the banks of the ditches or from soils in close proximity to the ditches. Soil samples collected as part of the November 2019 Containment Area soil boring program included laboratory analysis of soil samples for total chromium, hexavalent chromium and Toxicity Characteristic Leaching Procedure (TCLP). Laboratory analysis of these samples provided confirmation that trivalent chromium is the primary form of chromium in soils within the Containment Area, and that chromium in soil within the Containment Area was not sufficiently leachable to be of concern under the Resource Conservation and Recovery Act (RCRA). However, chromium observed in Containment Area soils could still leach to groundwater. Alternatives to address potential leaching of Site contaminants associated with the Containment Area into groundwater, surface water, and sediments at levels that pose unacceptable risks to human health and the environment are evaluated in the IAFS Report. Lake Poly soils also contain trivalent chromium which, as noted above is not readily water soluble.

Chromium is present in deep overburden groundwater at the Site at concentrations up to 1.2 mg/L and in shallow overburden groundwater at concentrations up to 0.021 mg/L and there is discharge of low concentration chromium-containing water to South Ditch. TCLP data from limited soils samples collected within the Containment Area indicate that chromium in soil is predominantly in the trivalent form, and the very low water solubility of trivalent chromium at typical pH of precipitation indicate that leaching from soils may not be the primary source of chromium in groundwater. The primary source of chromium in groundwater is the DAPL contained in three pools located in bedrock depressions (on-Property, within the Containment Area, and to the west of the Property, off-Property DAPL Pool and the Main Street DAPL Pool).

However, since chromium is present in groundwater beyond those areas impacted by the DAPL pools, all groundwater discharges containing chromium are evaluated in this FS.

The DAPL pools are remnants of the dense, acidic waste streams from the former facility that were disposed in unlined pits and lagoons, where the liquid waste percolated into the soil, migrated through the saturated zone, and accumulated at the bedrock surface. The DAPL material is acidic (pH of approximately 3.5) and has high concentrations of chromium, sodium, calcium, potassium, sulfate, chloride, and NDMA. These dissolved constituents (including chromium, which is more soluble at the low pH of this groundwater) diffuse from the DAPL into the overlying "diffuse" groundwater and are carried with groundwater as it migrates away from the DAPL pools.

Groundwater migrates from the areas of the DAPL toward South Ditch mixing with other groundwater resulting in gradual increases in pH. When the acidic groundwater discharges into South Ditch and mixes with higher pH surface water of the ditch, the surface water pH conditions favor flocculation of chromium as well as aluminum and iron and the substantial reduction in concentrations of dissolved chromium, aluminum, and iron. Since January 2017, concentrations of dissolved chromium in quarterly Upper South Ditch surface water samples were less than or equal to the chromium ambient water quality criterion and PRG of 0.10 mg/L (range 0.018 to 0.1 mg/L) and concentrations in quarterly samples from the Lower South Ditch during the same period were also less than or equal to the PRG of 0.10 mg/L (range 0.0081 to 0.048 mg/L).

Chromium, aluminum and iron in groundwater originating from the DAPL pools discharge to the South Ditch surface water and form a precipitate, or floc. Based on the data presented in the 2015 OU1/OU2 RI Report, hexavalent chromium was not identified in South Ditch surface water at a reporting limit ranging from 0.001 to 0.005 mg/L and it was not detected in floc. Formation of the floc material is driven by changes in aqueous pH and the floc is stable in the surface water environment (Geomega, 2004). The floc material is mobile, in that stormwater events result in the flushing of floc from the South Ditch to downstream locations. The floc material may also be incorporated in the South Ditch bottom substrate mixing with decaying leaf material and sediment.

One cause of the elevated concentrations of chromium in sediment and bank soil of the South Ditch is the historical acidic liquid waste discharges to the on-Property West Ditch that flowed to the South Ditch, where the chromium partitioned from the surface water to the sediments and to bank soil during high water conditions. Another potential contributor to sediment and bank soil chromium levels is dissolved-phase chromium from DAPL and diffuse groundwater. Chromium in sediments and bank soils adjacent to the South Ditch are not believed to be mobile. The chromium is not soluble and is therefore not leaching from either sediments or soils into the surface water or the ditches.

1.5.3 BEHP

BEHP from on-site operational releases impacted soils and sediments on the Site, including upland soils in the area of Plant B and Lake Poly, and sediment/wetland soils in and around South Ditch. BEHP sorbs strongly to soil and organic sediments and has very low water solubility under typical environmental conditions, which limits its potential to migrate in groundwater or surface water at substantial concentrations or to leach from soil or sediment to groundwater or surface water.

Elevated concentrations of BEHP in sediment and bank soil of the South Ditch are primarily the result of historical acidic liquid waste discharges to the on-Property West Ditch that flowed to the South Ditch, where the BEHP partitioned from the surface water to the sediments and bank soil during high water conditions. BEHP sediments and bank soils adjacent to the South Ditch are not believed to be mobile. The BEHP has very limited water solubility (3.0 μg/L), is tightly bound to sediment and soil, and is therefore not likely to leach from either sediments or soils into the surface water of the ditches.

There is no evidence of any substantial input of BEHP to the South Ditch under current conditions. The data indicates no plume of BEHP in groundwater that could potentially discharge to the South Ditch. The Plant B groundwater extraction and treatment system is containing BEHP in groundwater in that area, preventing potential migration of BEHP to the adjacent East Ditch.

1.5.4 Ammonia

As discussed previously, the principal source of ammonia to groundwater and therefore surface water is believed to be diffusion from DAPL to diffuse groundwater. Other potential lesser sources of ammonia and other contaminants that are present in South Ditch surface water may include leakage from the Containment Area and/or residual contamination in soil outside of the Containment Area. Ammonia is soluble in water but is not stable in most environments. It is easily transformed to nitrate in waters that contain oxygen and can be transformed to nitrogen gas in waters that are low in oxygen. The most important attenuation mechanism is likely to be sorption to organic substrates and dilution by surface water downstream. The importance of these processes is evident from the 2015 OU1/OU2 RI Report surface water data (2015 OU1/OU2 RI Report; Figure 4.1-31) where over a distance of approximately 1,600 feet from the confluence of South Ditch and East Ditch, the December 2010 concentrations of ammonia attenuate (decline) from 74 mg/L at ISCO-2 to 2.2 mg/L at EDSD/SW5(EDBS11) and the May 2011 concentrations of ammonia decline from 110 mg/L at ISCO-2 to 8.7 mg/L at EDSD/SW5(EDBS11).

1.6 Baseline Risk Assessment

The following subsections summarize the results of human health and ecological risk assessments completed at the OCSS.

1.6.1 Human Health Risk Assessment

The BHHRA, presented in the 2015 OU1/OU2 RI Report, evaluated cancer and non-cancer risks for industrial/commercial worker, and construction worker exposures to OU1 surface and subsurface soil and OU2 surface soil (EA5). The BHHRA Exposure Areas are shown on **Figure 1.3-2**. The BHHRA also evaluated cancer and non-cancer risks for potential trespasser exposures to OU1 surface soil and subsurface upland soil and OU2 surface soil (EA5) and to OU1 and OU2 surface water and sediment at all areas except Landfill Brook. With one exception, these evaluations indicate cancer risks are below or within the CERCLA acceptable risk range for all receptors evaluated and non-cancer HI values are below or equal to 1. The calculated cancer risk for a trespasser exposure to surface water of the Off-Property West Ditch was above the

CERCLA risk range due to concentrations of benzo(a)pyrene and other PAHs. Additional evaluation of the source of the PAHs detected in this off-site surface water will be conducted as part of the pre-design investigation studies and mitigation of benzo(a)pyrene is considered in the alternatives included in this FS.

1.6.1.1 2015 Human Health Risk Assessment Conclusions

The conclusions of the 2015 BHHRA were as follows:

- Human health risks associated with potential direct contact (ingestion and dermal contact and inhalation of dust where applicable) exposures to surface soil, subsurface soil, surface water, and sediment at OU1 indicate that the northern portion of OU1 (EA1, EA2, EA3, EA6, EA7, including the on-PWD, South Ditch, Central Pond, and the Stormwater Retention Basin) is suitable for current and future industrial/commercial use. EA4 is within the Conservation Area.
- Human health risks associated with potential trespasser, industrial/commercial worker, and construction worker exposures to OU2 surface soil at EA5 indicate the area is suitable for industrial/commercial use.
- Human health risks associated with potential trespasser exposures to OU2 surface water and sediment at the South Ditch, East Ditch, Maple Meadow Brook, off-PWD, and North Pond indicate no trespasser exposure concerns for substances associated with releases at and from the OCSS. Further evaluation of human health risks associated with East Ditch was conducted in *Response to Memorandum "Olin - Plant B/East Ditch Risk Evaluation V2 dated August 27, 2019 and prepared by Nobis Group"* (Wood, 2019c).
- Inhalation non-cancer risks potentially associated with vapor intrusion for future buildings (indoor workers) and for future excavation of soils (construction workers) should be controlled via institutional and engineering controls such as the incorporation of vapor mitigation features into building design. This conclusion specifically relates to TMPs in subsurface soil in EA3, EA7, and a portion of the former Lake Poly area.

1.6.1.2 Updates to 2015 Human Health Risk Assessment Conclusions

EPA's position on certain public health risks has evolved since the issuance of the BHHRA.[5] There are current and potential risks posed by contaminants associated with the Site, that need to be addressed through implementation of a cleanup plan to make the Property suitable for industrial or commercial use.

The BHHRA also concluded that unacceptable risks to a trespasser could exist from exposure to benzo(a)pyrene and other polycyclic aromatic hydrocarbons (PAHs) in surface water within Off-Property West Ditch but asserted that such contaminants are unrelated to historical activities or releases at the Property and that such risks do not warrant further investigation nor evaluation in the FS report.[6]

EPA acknowledges the possibility of additional off-site, upgradient commercial/industrial sources of benzo(a)pyrene and other PAHs to the Property. However, benzo(a)pyrene and other PAHs were detected in surface and subsurface soil on the Property, with the highest concentrations occurring in the vicinity of the former Plant C Boiler and the former Laboratory Building Boiler near the Guard Shack. EPA's goal is to reduce, to the extent practicable, any sources of PAHs, including benzo(a)pyrene. Therefore mitigation of these sources, if coming from the Property, will be evaluated in this FS.

The BHHRA, presented in the 2015 OU1/OU2 RI Report, also provided a qualitative evaluation of potential future VI concerns associated with volatile compounds (primarily TMPs) in EA7 and EA3, and in a smaller area within EA1, as identified by a sample at the former Lake Poly Area. During development of the 2015 OU1/OU2 RI Report, there were no USEPA-published soil screening values which are protective of future VI exposures. As such, potential risks resulting from VI from soil to hypothetical future buildings is difficult to quantify and evaluate. Indoor air sampling and analysis in the Plant B treatment building indicated that there is not a complete VI pathway for TMPs. The office trailer construction indicates negligible potential for VI of TMPs (the trailer is an above ground structure). TMP concentrations in bulk soil samples collected

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[5] See Memorandum, *Olin Chemical Superfund Site, Updates to OU1/OU2 RI Report Conclusions,* EPA, date, 2020.
[6] See 2015 OU1/OU2 RI Report, Executive Summary (p. ES-24).

immediately north of Plant B and the PID screening of these soil samples (PID readings as high as 3,000 ppm) indicate that VI is a concern for indoor workers and occupants of future buildings that might be constructed in this portion of the OCSS.

Additionally, limited soil sampling was conducted throughout the main operations area of the Site (HH-EA1) due to obstructions related to remaining buildings and concrete foundations, raising the possibility that elevated levels of TMPs may be present in these areas. The limited characterization of soil beneath the remaining facility buildings and foundations introduces the possibility that contaminants such as TMPs could be present at sufficient concentrations elsewhere on the Site to result in unacceptable exposures should buildings be constructed and occupied in areas where elevated levels of TMPs are present that could result in an unacceptable vapor intrusion risk.

In the future it is possible for redevelopment of the Property to occur such that a complete subsurface-to-indoor air vapor intrusion pathway could exist, thus requiring potential remedial actions to address or eliminate VI risks if the TMP concentrations in soil are not otherwise addressed.

Human health risk associated with hypothetical residential use of the Property were not evaluated in the BHHRA. EPA has conducted conservative risk screening calculations and human health risks associated with potential direct contact (ingestion and dermal contact and inhalation of dust where applicable) with soil by potential future residents indicate that the Property may not be suitable for future residential use.

1.6.2 Ecological Risk Assessments

The BERA, Appendix N of the 2015 OU1/OU2 RI Report, characterized risk by media, exposure area and assessment/measurement endpoints, beginning with the terrestrial exposure areas and concluding with the semi-aquatic exposure areas. The BERA Exposure Areas are shown on **Figure 1.3-3**.

1.6.2.1 2015 Ecological Risk Assessment Conclusions

The 2015 BERA found that adverse effects associated with releases at or from the OCSS to ecological receptors are unlikely in the following exposure areas and media:

- BERA EA2 soil;
- BERA EA4 soil;
- Central Pond surface water and sediment;

- Storm Water Retention Basin surface water and sediment;
- On-PWD/West Ditch Wetland surface water and sediment;
- Upper South Ditch sediment;
- Maple Meadow Brook surface water and sediment; and
- North Pond surface water and sediment.

The 2015 BERA also found that adverse effects associated with releases at or from the OCSS to ecological receptors may be possible in the following exposure areas and media:

- EA5 soil, due to chromium and BEHP;
- Upper South Ditch surface water, due to chromium and ammonia; and
- Lower South Ditch surface water due to chromium and ammonia and sediment due to chromium and BEHP.

Based on the data presented in the 2015 OU1/OU2 RI Report, including the BERA and BHHRA, as well as the Technical Memorandum *Hexavalent Chromium in Groundwater, Surface Water, Sediment, and Soil at the Olin Chemical Superfund Site* (Wood, 2020a), hexavalent chromium was not identified as a COC in surface water, sediment, upland soil or wetland soil.

1.6.2.2 Updates to 2015 Ecological Risk Assessment Conclusions

EPA's position on certain risks to ecological receptors has evolved since the issuance of the BERA.[5] Soil and sediment ecological risk-based PRGs have been developed to address possible adverse effects for the American robin, shrew, and marsh wren associated with chromium and BEHP in upland and wetland soil in EA5 and for aquatic invertebrates and insect-eating birds associated with chromium and BEHP in Lower South Ditch sediments. In this FS, the ecological risk-based soil PRGs for EA5 and the PRGs for Lower South Ditch sediments have been used to identify additional soil and sediment areas that are included in the remedial alternatives to address chromium and BEHP in soils, and chromium and BEHP in sediments. Other areas of the Site with soil or sediments with concentrations greater than chromium and BEHP PRGs have been included in the soil and sediment remedial alternatives. For the purposes of this FS, it is assumed adverse effects to ecological receptors may be possible in these areas with concentrations of chromium and BEHP greater than corresponding PRGs. The additional areas included in the alternatives include BERA-EA1, -EA2, -EA3, -EA4, -EA7, and the Containment Area for soils and the Off-Property West Ditch, and Upper South Ditch for sediments.

The 2015 BERA did not identify potential adverse ecological impacts to East Ditch, due to the identification of this surface water feature in the BERA as of poor habitat quality. USEPA and MassDEP consider East Ditch to be a Class B surface water body, and while USEPA acknowledges access issues and maintenance practices negatively affect East Ditch habitat, East Ditch does present a potential source of contaminants to downstream receptors if contaminated groundwater were to discharge to the ditch in the future should Plant B cease operation. Thus, remedial alternatives associated with potential groundwater discharge from the Plant B area to East Ditch are evaluated in this FS.

In Section 2 of this FS, PRGs are developed for COCs for wetland soil in E-EA5, South Ditch surface water, and Lower South Ditch sediment to address the ecological risks identified above. Ecological risk-based PRGs for chromium and BEHP in upland soil have also been developed. While other areas of the Site were not identified as presenting potential risk, chemical data from the entire Site were compared to the PRGs to identify areas for which to develop and evaluate remedial alternatives. Based on the application of the PRGs to the entire Site, remedial alternatives have been developed and evaluated for the following media and locations in addition to the areas where potential risks were identified: OU1 upland soils (chromium and BEHP), OU1 wetland soils (chromium and BEHP), OU1 and OU2 sediment (chromium and BEHP) at off-PWD and Central Pond, and OU1/OU2 surface water (chromium and ammonia) for the East and South Ditches.

1.6.3 Risk Assessment Conclusions

The nature and extent of contamination for OU1/OU2 soil, surface water, and sediment have been sufficiently characterized to support the remedial alternatives evaluated in this FS. The data are adequate to support risk characterization and risk management decisions. The conclusions of the OU1/OU2 RI, including modifications reflecting EPA's current positions, clarifications, and understanding, are provided below:

- Federal National Recommended Water Quality Criteria (NRWQC) are identified as action-specific TBCs for surface water[7] to be used in evaluation of health effects to be protective of aquatic life, as well as in the development of PRGs and remedial target levels.
- The human health risk assessment indicates the Property overall is suitable for industrial/commercial use, conditioned upon addressing risks to trespassers and future building occupants and indoor workers.
- TMPs in soil in the northern portion of the Property associated with EA7 and EA3 and to a lesser extent one location near former Lake Poly area in EA1 could pose potential VI risks to indoor workers and occupants of future buildings. However, due to the limited nature of the sampling throughout the main operations area of the Site (HH-EA1), it is possible that elevated levels of TMPs may be present in areas other than the specific areas identified above. Thus, development throughout all of HH-EA1, in addition the areas specified above, should be evaluated in this FS for potential engineering controls or remedial actions required to mitigate potential future VI concerns and potential future construction worker exposures
- The ecological risk assessment identified exposure area E-EA1 as developed land with no substantial terrestrial habitat and therefore did not evaluate risk for ecological receptor exposures to soil in that area. This FS assumes that E-EA1 or portions of E-EA1 may currently provide habitat for birds and that in the future, E-EA1 could return to a more robust terrestrial habitat. Ecological risk-based criteria are therefore applied to E-EA1 in this FS.
- The BERA for OU1 and OU2 evaluated distinct EAs and found that adverse effects related to releases at or from the OCSS may be possible for Lower South Ditch sediment and EA5 soil, due to chromium and BEHP. The ecological risk-based soil PRGs for EA5 and the PRGs for Lower South Ditch sediments have been used to identify additional soil and

[7] No chemical-specific ARARs were identified for the alternatives to address contamination in surface water. Site-specific surface water criteria were identified in this FS to ensure that the groundwater extraction and treatment remedy to address surface water contamination is successful in reducing contaminant levels in surface water to be protective of ecological receptors. The surface water alternatives developed in this FS will achieve action-specific ARARs because the effluent from the treatment system will be treated prior to discharge to surface waters. Additionally, any impacts to wetlands from construction of the groundwater treatment system will be mitigated, thus achieving location-specific ARARs.

sediment areas that are included in the remedial alternatives to address chromium and BEHP in soils and chromium and BEHP in sediments as discussed above.

- At the time the 2015 OU1/OU2 RI Report was prepared, surface water in Upper and Lower South Ditch showed potential adverse effects to ecological receptors primarily due to ammonia and chromium. Therefore, it was recommended that South Ditch surface water be evaluated in the OU1/OU2 FS. Since 2015 when the OU1/OU2 RI Report was finalized, chromium and ammonia concentrations in South Ditch surface water have declined appreciably. The primary source of ammonia and chromium is groundwater adjacent to and underlying the ditch, which has also shown appreciable declines in concentrations. However, EPA has concerns that Site contaminants in groundwater in the area of Plant B could potentially impact the ecological quality of East Ditch should Plant B cease operation. Thus, remedial alternatives associated with potential groundwater discharge from the Plant B area to East Ditch were also evaluated in this FS.
- The BHHRA and BERA indicated no human health or ecological risk concerns for OU1 surface water and sediment of the Central Pond and the Stormwater Retention Basin and for OU2 surface water and sediment in the East Ditch, Maple Meadow Brook wetland and North Pond, and that those water bodies do not need to be evaluated in the OU1/OU2 FS. However, sediment PRGs for chromium and BEHP that were derived for the South Ditch are applied to the off-PWD and Central Pond in this FS.
- The BHHRA also concluded that unacceptable risks to a trespasser could exist from exposure to benzo(a)pyrene and other polycyclic aromatic hydrocarbons (PAHs) in surface water within Off-Property West Ditch, and therefore, surface water PRGs were also developed for the Off-Property West Ditch for benzo(a)pyrene to address potential risk.

2.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

This section identifies and screens remedial technologies using the process outlined in the NCP and USEPA RI/FS guidance (USEPA, 1988b). This section discusses the RAOs, ARARs, COCs, and PRGs, identifies appropriate general response actions, and identifies and screens technologies.

2.1 Remedial Action Objectives

This section identifies the overall RAOs based on the human health and ecological risks identified in the OU1/OU2 RI Report and summarized in Section 1.0 as well as meeting PRGs and compliance with ARARs. This section identifies medium-specific COCs and PRGs (based on ARARs and human and ecological risks) that represent allowable exposure levels (medium-specific concentrations) for each of the medium-specific COCs. The medium-specific PRGs for the COCs are considered target concentrations for the purposes of identifying and screening technologies that might be components of remedial alternatives.

This OU1/OU2 FS is focused on remedial alternatives to address the following conditions at the OCSS:

- TMPs in soil (where future buildings may be constructed) – subsurface-to-indoor air vapor intrusion risks to public health
- Chromium and BEHP in upland soil, wetland soil, streambank soil, and sediments – ecological receptor risk
- Chromium and ammonia in South Ditch surface water – ecological receptor risk and NRWQC
- Chromium and ammonia in East Ditch surface water – ecological receptor risk and NRWQC
- PAHs, including benzo(a)pyrene, in Off-Property West Ditch surface water – human health risks (ingestion and dermal contact) to trespassers

The RAOs are as follows:

<u>RAO for Upland Soil:</u>

- Prevent potential human exposure by a future indoor worker or building occupant to indoor air vapors, via a vapor intrusion pathway, containing Site contaminants at levels that pose an unacceptable risk.

- Prevent exposure by current and future ecological receptors to upland soil containing Site contaminants that would result in potential adverse impacts.

<u>RAOs for wetland soil and sediment:</u>

- Prevent exposure by current and future ecological receptors to wetland soil and sediments containing Site contaminants that would result in potential adverse impacts.
- Prevent the further migration of wetland soil and sediments containing Site contaminants to nearby wetlands, surface water, drainage features, and adjoining properties that would result in potential adverse impacts.

<u>RAO for surface water:</u>

- Prevent migration of groundwater containing Site contaminants to East Ditch, South Ditch, and Off-Property West Ditch to prevent exposure by current and future ecological receptors to surface water containing Site contaminants that would result in potential adverse impacts. and
- Prevent migration of groundwater containing Site contaminants to Off-Property West Ditch to prevent potential human exposure by a current or future trespasser to surface water containing Site contaminants at levels that pose an unacceptable risk.

The following are RAOs for LNAPL near Plant B; however, LNAPL associated with the OCSS is included in the IAFS Report. Remedial alternatives to address LNAPL are presented in Section 4.2 of the IAFS Report.

- Prevent migration of LNAPL to East Ditch to prevent exposure by current and future ecological receptors to Site contaminants that would result in potential adverse impacts.
- Remove, to the extent practicable, LNAPL that represents a source of Site contaminants to groundwater and a source of TMPs to indoor air vapors, via a vapor intrusion pathway, that pose an unacceptable risk to future indoor workers or building occupants.

2.1.1 Applicable or Relevant and Appropriate Requirements

In this section ARARs are discussed for the purpose of describing ARARs-based allowable exposure levels that should be considered in screening remedial technologies and developing and evaluating remedial alternatives. These allowable exposure levels are typically identified by chemical-specific ARARs. ARARs also are important considerations for screening of technologies and development and evaluation of remedial alternatives, because location-specific and action-specific ARARs may require certain actions with respect to remedial activities and may limit or prohibit certain other technologies or remedial actions. CERCLA and the NCP require that on-site Superfund remedial actions must attain federal standards, requirements, limitations, or more stringent state standards determined to be legally applicable or relevant and appropriate to the circumstances at a given site. ARARs are federal and state environmental and facility siting requirements used to: (1) evaluate the appropriate extent of site cleanup; (2) define and formulate remedial action alternatives; and (3) govern implementation and operation of the selected action. Inherent in the interpretation of ARARs is the assumption that protection of human health and the environment is ensured.

To properly consider ARARs and to clarify their function in the remedy selection process, the NCP defines two ARAR components: (1) applicable requirements; and (2) relevant and appropriate requirements. These definitions are discussed in the following paragraphs.

Applicable Requirements. Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site (40 CFR 300.400(g)). To be applicable, a requirement must directly and fully address a CERCLA activity.

Relevant and Appropriate Requirements. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations that, while not applicable to a hazardous substance, pollutant, contaminant, remedial action, location or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the site that their use is well-suited to the particular site (40 CFR 300.400(g)(2)).

There is another category of information that is often considered in the ARARs analysis but that are not actually ARARs. Those are non-promulgated guidance, recommendations, and other information that may be used in the absence of ARARs, where ARARs are not sufficiently protective to develop cleanup goals, or when necessary to ensure protectiveness. These items are referred to as "To Be Considered" items or "TBCs." For the purpose of this FS, the term "ARARs" include TBCs.

ARARs are divided into the three categories described in the following paragraphs.

Location-specific ARARs set restrictions upon the concentration of hazardous substances or the conduct of activities solely because they are in special locations. In determining the use of location-specific ARARs for selected remedial actions at CERCLA sites, one must investigate the jurisdictional prerequisites of each of the regulations. Basic definitions and exemptions must be analyzed on a site-specific basis to confirm the correct application of the requirements.

Chemical specific ARARs are usually health- or risk-based numerical values or methodologies that establish the acceptable amount or concentration of a chemical that may remain in, or be discharged to, the environment (USEPA, 1988a). They govern the extent of site remediation by providing either actual cleanup levels, or the basis for calculating such levels. For example, drinking water Maximum Contaminant Levels provide cleanup goals for sites with contaminated groundwater (relevant and appropriate for current and/or future potable use groundwater). At the OCSS, no chemical-specific ARARs were identified for the alternatives to address contamination in surface water, however, site-specific ecological and human health surface water preliminary remediation goals will be used to evaluate whether the selected remedy is successful in reducing contaminant levels in surface water to be protective of ecological and human health receptors.

Action-specific ARARs are usually technology- or activity-based requirements or limitations on remedial actions taken (USEPA, 1988a). Selection of a particular response action at a site will invoke the appropriate action-specific ARARs that may specify particular performance standards or technologies, as well as specific environmental levels for discharged or residual chemicals.

Many regulations can fall into more than one category. For example, many location-specific ARARs are also action-specific because they are triggered if response activities affect site features. Likewise, many chemical-specific ARARs are also location-specific.

NRWQC were identified in this FS to ensure that the groundwater alternatives to address surface water contamination is successful in reducing contaminant levels in surface water to be protective of ecological receptors, more specifically for chromium and ammonia. Consistent with USEPA procedures for application of these criteria, site-specific conditions (water hardness, pH, and temperature as well as presence/absence of specific types of aquatic receptors) have been used to derive site-specific NRWQC.

If treated groundwater is discharged to a surface water body, the treated effluent would need to meet the substantive discharge standards of the National Pollutant Discharge Elimination System (NPDES) and the Massachusetts Surface Water Discharge Permit Program. Surface water alternatives were developed in this FS to achieve action-specific ARARs, because the effluent from the treatment system will be treated prior to discharge to surface waters.

The Occupational Safety and Health Administration (OSHA) has promulgated standards for protection of workers who may be exposed to hazardous substances at RCRA or CERCLA sites.

USEPA requires compliance with the OSHA standards in the NCP, not through the ARAR process. Therefore, the OSHA standards are not considered as ARARs. Although the requirements, standards, and regulations of OSHA are not ARARs, they will be complied with during response activities.

Preliminary Identification of ARARs. The location-, chemical-, and action-specific ARARs identified in support of this FS are presented by media. **Tables 2.1-1 through 2.1-3** present location-, chemical-, and action-specific ARARs for soils containing TMPs. **Tables 2.1-4 through 2.1-6** present location-, chemical-, and action-specific ARARs for upland soils. **Tables 2.1-7 through 2.1-9** present location-, chemical-, and action-specific ARARs for wetland soil and sediment. **Tables 2.1-10 through 2.1-11** present location- and action-specific ARARs for surface water.

In summary, location-specific ARARs include federal and state regulations related to wetlands and surface waters. Chemical-specific ARARs include information for human health and ecological exposures, and vapor intrusion evaluations. Action-specific ARARs include federal and state regulations relative to: RCRA identification and listing of hazardous waste; standards applicable to generators of hazardous waste; RCRA requirements for storage and disposal of hazardous waste; and NRWQC for aquatic life and toxicity.

2.1.2 Chemicals of Concern

COCs have been identified as those chemicals that substantially contribute to current or potential future human health or ecological risk, or that have concentrations that are above PRGs or ARARs criteria. The primary COCs (those contaminants that are the focus of the remedial alternatives) associated with the environmental media addressed in the OU1/OU2 FS Report are summarized as follows:

- TMPs in subsurface soil in the northern portion of the Property associated with the Plant B area in H-EA7, H-EA3, and the former Lake Poly area within H-EA1 based on potential vapor intrusion risks to public health in future occupied buildings;
- Chromium and BEHP in multiple areas of upland soil based on risk to ecological receptors;
- Chromium and BEHP in multiple areas of wetland soil and sediments based on risk to ecological receptors;
- Chromium and ammonia in South Ditch and East Ditch surface water based on risk to ecological receptors;

- PAHs, including benzo(a)pyrene, in Off-Property West Ditch surface water based on human health risks to trespassers.

2.1.3 Development of Preliminary Remediation Goals

PRGs are medium-specific concentrations used during analysis and selection of remedial action alternatives and cleanup levels. PRGs should comply with ARARs and be associated with residual risks consistent with NCP requirements for protection of human health and the environment. Therefore, there are both ARAR-based PRGs and risk-based PRGs. PRGs may be modified and/or potentially become the basis for final remediation levels for the selected remedy.

2.1.3.1 Human Health Risk-Based Vapor Intrusion PRGs for TMPs - Indoor Air

Based on information presented in the 2015 OU1/OU2 RI Report and the associated BHHRA, there are no occupied buildings in contact with ground surface at location of TMPs in subsurface soils, and therefore, there is not a complete VI pathway under current Site conditions.

However, for TMPs detected in soil samples collected from EA1, EA3, and EA7, appropriate field-screening information indicate a potential concern for vapor intrusion into future occupied buildings. In the BHHRA, it was not possible to estimate VI-related potential indoor air concentrations and associated industrial/commercial employee risks for future buildings without significant uncertainty.

However, to inform the identification and screening of technologies and for development of remedial alternatives, human health risk-based industrial/commercial indoor air PRGs for TMPs (level that would be without appreciable risk of adverse effects for long-term exposure) have been calculated as described below. It is not possible to predict if a future VI pathway would be complete and whether TMP concentrations would be above a PRG without knowledge of a future building's design, construction methods, materials, and location. However, potential VI risks may be addressed by preventing vapor intrusion into a building, or by removing and/or treating soil with elevated TMP concentrations.

The human health indoor air PRGs for TMPs were developed using USEPA toxicity information and commercial/industrial worker exposure assumptions. TMPs are not classified as carcinogens by USEPA. Therefore, the indoor air PRGs have been developed based on toxicity information for non-cancer effects.

The November 2019 USEPA Regional Screening Levels (RSLs) Table for Industrial Soil (USEPA, 2019) lists an oral non-cancer Reference Dose (RfD) of 0.01 mg/kg/day for 2,4,4-trimethylpentene (CAS# 25167-70-8) but the RSLs tables do not list an Inhalation Reference Concentration (RfC) for TMPs. This suggests that sufficient, definitive inhalation toxicity information is not available for deriving an air concentration that would be without appreciable risk of adverse effects for long-term exposure. An often-used approach called route-to-route extrapolation has been employed to estimate a concentration analogous to an Inhalation RfC. Using this approach, an air concentration can be calculated using standard inhalation exposure assumptions and bodyweights that would yield a dose equal to the Oral RfD. That estimated air concentration for continuous long-term exposure is 0.04 milligrams per cubic meter (mg/m^3). That number was then converted using standard industrial/commercial worker exposure parameters to derive industrial/commercial indoor air PRGs at Hazard Quotients of 1 and 0.1.

The PRGs were developed for a commercial/industrial indoor worker being on-site 8 hours per day for 250 days per year. The calculated indoor air PRGs for TMPs, based on target Hazard Quotients (HQs) of 1 and 0.1 are summarized below. PRGs are typically calculated for target levels of 1 and 0.1 to be able to address scenarios with multiple COCs and RAOs that call for a cumulative hazard index (sum of HQs) of one or less.

Commercial/Industrial Indoor Air PRG for TMPs in Soil at BHHRA EA1, EA3, and EA7

For Target HQ = 1	Total TMPs PRG = 0.175 mg/m^3
For Target HQ = 0.1	Total TMPs PRG = 0.0175 mg/m^3

2.1.3.2 Human Health Risk-Based PRGs for TMPs in Soil

Soil PRGs (source medium PRGs) that address VI were not established for TMPs due to the uncertainty with predicting indoor air impacts caused by soil contamination. Due to this uncertainty, this FS identifies and evaluates vapor intrusion-based remedial alternatives for soil areas where TMPs are most frequently detected. These areas have been defined by either the calculated Industrial/Commercial Direct Exposure surrogate described in Section 1.4.1 or by elevated PID screening levels.

The vapor intrusion pathway involves volatilization of TMPs from the soil matrix into soil vapor and subsequent migration of soil vapor into occupied structures. Therefore, development of PRGs for TMPs would require establishing definitive relationships between TMP concentrations in subsurface soil, soil vapor, and indoor air within future buildings with yet-to-be determined construction characteristics, and heating, ventilation, and air conditioning systems. Because construction specifications or potential future buildings are not known, we have identified general areas for feasibility evaluation that will be confirmed during pre-design investigations or as part of Property redevelopment.

2.1.3.3 PRGs for Soil, Sediments and Surface Water

Section 2.1.2 identified the COCs for each medium and location that is addressed in this OU1/OU2 FS. PRGs have been developed for the following scenarios:

- Chromium and BEHP in upland soil, wetland soil, streambank soil, and sediments based on risk to ecological receptors;
- Benzo(a)pyrene in surface water based on human health risks to trespassers; and
- Chromium and ammonia in surface water based on risk to ecological receptors

The PRGs were developed collaboratively between USEPA and the Olin representatives in consideration of ARARs and both human health and ecological risks identified for the media identified above in the BHHRA and the BERA that were included as Appendix M and N in the 2015 OU1/OU2 RI Report.

The BHHRA concluded that calculated Reasonable Maximum Exposure (RME) cancer risk and noncancer Hazard Index values were below 10^{-4} and 1, respectively, for soil exposure (incidental ingestion, dermal contact, and inhalation of soil-derived dust), and sediment (incidental ingestion and dermal contact). A human health risk-based surface water PRG (incidental ingestion and dermal contact) for a trespasser was derived to support the feasibility study.

Consistent with USEPA guidance and standard practice, the BERA included evaluation of multiple assessment endpoints and measurement endpoints listed in the table on pages 3-13 and 3-14 of the BERA. Each of the assessment endpoint/measurement endpoint combinations in the table were assigned an Inference Weight (Low, Medium, High) that is used in interpreting the results for the various assessment endpoint/measurement endpoint combinations. The BERA evaluated risks to ecological receptors based on multiple assessment endpoints and measurement endpoints using a Four-Way Interpretive Risk Matrix and a Two-Way Interpretive Matrix that had previously been developed for USEPA (pages 5-1 and 5-2 of the BERA).

Based on the BERA conclusions, ecological risk-based PRGs have been derived for chromium and BEHP in soil (upland soil, wetland soil, and streambank soil), chromium and BEHP in sediments, and chromium and ammonia in surface water. The PRGs for upland soil, wetland soil, streambank soil, and sediments were derived using the risk calculations for food chain exposure modeling which were identified as having medium or high inference weight in the ecological risk characterization. For each medium and exposure scenario, chemicals with Hazard Index values above 1 for RME scenarios were identified as COC candidates. The ecological risk-based COCs for soil and sediments are those identified in the bullet list above. The PRGs for soil and sediments represent concentrations associated with target Hazard Index values of 1 as calculated from the food chain exposure risk calculation spreadsheets.

The COCs for surface water were identified as the Site-related contaminants with concentrations in surface water of the South Ditch that had concentrations above screening benchmarks and site-specific chronic Ambient Water Quality Criteria. Those COCs are chromium and ammonia. The surface water PRGs for chromium and ammonia are identified as the site-specific chronic National Recommended Water Quality Criteria.

The human health and ecological risk-based PRGs for soil, sediments and surface water are identified in **Table 2.1-12** The detailed documentation of the technical basis and the derivation of these PRGs is included in the July 1, 2020 Technical Memorandum *Documentation of Preliminary Remediation Goals (PRGs) to Address Human Health Risks in Dense Aqueous-Phase Liquid (DAPL), Groundwater Hot Spots, Upland Soil (including Containment Area soil), and Surface Water at the Olin Chemical Superfund Site* (Wood, 2020c) and the May 15, 2020 Technical Memorandum *Documentation of Preliminary Remediation Goals (PRGs) for Soils, Sediments, and Surface Water at the Olin Chemical Superfund Site* (Wood, 2020d).

2.2 General Response Actions

General response actions are categories of remedial actions that may be used to satisfy RAOs by either reducing the contaminant concentration in each medium below the PRG or by preventing receptor exposure to the contaminated medium. General response actions describe categories of remedial actions that may be employed to satisfy remedial action objectives and provide the basis for identifying specific remedial technologies.

Potential general response actions for upland soil impacted with chromium, BEHP, and/or TMP are:

- No Action
- Institutional Controls
- Containment
- Treatment
- Removal

- Disposal

Potential general response actions for wetland soil, streambank soil, and sediments impacted with chromium and BEHP are:

- No Action
- Institutional Controls
- Containment
- Treatment
- Removal
- Disposal

Potential general response actions for surface water are:

- No Action
- Institutional Controls
- Containment
- Treatment
- Removal

2.2.1 Areal Extent of Media with Concentrations Above PRGs (Estimated Remediation Areas)

This subsection presents the areal extent concentrations of COCs above the PRGs identified in Section 2.1.3.1 and 2.1.3.2 for soil and sediments, and surface water. This section identifies the estimated surface area concentrations above PRGs for TMPs in soil, and chromium and BEHP in upland soil, wetland soil, streambank soil, and sediments.

2.2.1.1 TMPs in Soil

The remedial alternatives for TMPs in soil are intended to mitigate actual or potential impacts to public health resulting from subsurface-to-indoor air vapor intrusion into future buildings at the Site.

The areal extent of TMP in subsurface soil is shown on **Figure 2.2-1** and is summarized as follows:

- Plant B and HH-EA7: approximately 23,000 square feet

- HH-EA3: approximately 5,000 square feet
- Lake Poly (HH-EA1): approximately 2,500 square feet

TMPs are primarily present in soil in these areas in an approximate 5-foot thick smear zone that straddles the groundwater surface, which is approximately 7-8 feet below ground surface.

2.2.1.2 Chromium and BEHP in Upland Soil

The remedial alternatives for chromium and BEHP in upland soil are intended to prevent ecological receptor exposure to soil with chromium and/or BEHP at concentrations above the upland soil PRGs of 1,000 mg/kg for chromium and 3 mg/kg for BEHP. The areal extent of chromium and BEHP in surface soil and subsurface soil is shown on **Figures 2.2-2 and 2.2-3**, respectively.

The estimated remediation areas for upland surface soil (0 to 1 foot bgs), identified in **Figure 2.2-2** are summarized as follows:

- Former Plant B area within E-EA1;
- Former Plant C-1 area within E-EA1;
- Two small areas east of the current Plant B treatment building (E-EA3);
- Former Lake Poly area within E-EA1;
- An area between the former Lake Poly and the Containment Area;
- Small area immediately east of the East Warehouse (HH-EA1);
- An area between the Containment Area and the Central Wetland within E-EA4;
- Two single locations east of the former Plant D Tank Farm in E-EA1 and at the northwest corner of the Containment Area within E-EA2.

Estimated remediation areas for upland shallow subsurface soil (1-10 feet bgs), shown on **Figure 2.2-3**, are summarized as follows:

- Former Plant B area and immediately to the north within E-EA1;
- Former Plant C-1 area within E-EA1;
- Former Boiler House area within E-EA1;
- An area at and east of the current Plant B treatment building (E-EA3);
- Former Lake Poly area within E-EA1;
- An area immediately east of the East Warehouse and the area of the former Plant D (H-EA1);
- A small area between the Containment Area and Central Pond within E-EA4;

- Two single locations at the current guard shack E-EA1 and at beneath the East Warehouse within E-EA1.

The surface area associated with the lists above is approximately 52,000 square feet.

2.2.1.3 Chromium and BEHP in Wetland Soil and Sediment

The remedial alternatives for chromium and BEHP in wetlands soil and aquatic sediment are intended to 1) prevent exposure by current and future ecological receptors to these media containing Site contaminants that would result in potential adverse impacts and 2) to prevent the further migration of soils containing Site contaminants to nearby wetlands, surface water, drainage features, and adjoining properties that would result in potential adverse impacts. The areal extent of chromium and BEHP in wetland surface soil and sediment is shown on **Figure 2.2-4** and in wetland shallow subsurface soil in **Figure 2.2-5.**

2.2.1.3.1. Wetland Soil

Estimated remediation areas for wetland surface soil (0-1 foot bgs), shown on **Figure 2.2-4**, are summarized as follows:

- A wetland area in the southern portion of E-EA2, immediately north of the Containment Area and adjacent to the on-Property West Ditch;
- A wetland area adjacent to both the north and south sides of the Lower South Ditch that spans the eastern boundary of the Property. The upstream portion of this area is on-Property within E-EA4 and the downstream portion of the area is Off-Property and is referred to as E-EA5.
- Three single locations within the Central Wetland located within E-EA4;
- Three single locations in the wetland to the south of the Upper South Ditch located within E-EA4.

Estimated remediation areas for wetland shallow subsurface soil (1-10 feet bgs), shown on **Figure 2.2-5**, are summarized as follows:

- A wetland area in the southern portion of E-EA2, immediately north of the Containment Area and adjacent to the on-Property West Ditch;
- An Off-Property wetland area adjacent to both the north and south sides of the Lower South Ditch within E-EA5.
- One single location within the Central Wetland located within E-EA4;

The surface area associated with the wetland surface soils (0-1 foot) is estimated at approximately 106,500 square feet. The footprints of the estimated remediation areas for wetland shallow subsurface soils (from 1-10 feet) are substantially smaller, measuring approximately 5,000 square feet.

2.2.1.3.2. Sediment

Estimated remediation areas for aquatic sediment, shown on **Figure 2.2-4**, are summarized as follows:

- Entire length of South Ditch extending east from immediately downstream of the concrete weir structure beyond the eastern Property line and to the confluence with the East Ditch. The estimated remediation area includes aquatic sediment as well as soils located between the top of the north bank and the south bank of the South Ditch.
- The northern portion of the off-PWD;
- Central Pond.

The surface area of the estimated wetland surface soil and ditch sediment remediation areas identified above is approximately 106,500 square feet.

2.2.1.4 Chromium, Ammonia, and Benzo(a)pyrene in Surface Water

Remedial alternatives for chromium and ammonia in surface water are intended to prevent exposure by current and future ecological receptors to South Ditch and East Ditch surface water containing Site contaminants that would result in potential adverse impacts. These alternatives are also intended to prevent potential human exposure (ingestion and dermal contact) by a current or future trespasser to off-Property West Ditch surface water containing benzo(a)pyrene at concentrations that pose an unacceptable risk. The remedial alternatives include No Action and Limited Action (monitoring of groundwater and surface water) and active measures associated with groundwater, since the current and potential future surface water impacts are associated primarily with groundwater/surface water interaction. The areas of surface water to be protected are identified on **Figure 2.2-6**. These areas include the South Ditch (from the western Property boundary eastward to the confluence with the East Ditch), the Off-Property West Ditch, as well as the East Ditch from the northern Property boundary southward to the confluence with the South Ditch.

Although ammonia concentrations in South Ditch surface water have been declining overall, concentrations fluctuate considerably, with intermittent concentrations well above the PRG

(NRWQC). Dissolved chromium concentrations in surface water of the South Ditch have also declined and have been consistently below the surface water PRG in recent sampling events.

Chromium and ammonia concentrations in East Ditch surface water adjacent to the Property have consistently been below corresponding site-specific NRWQC. In consideration of the Plant B groundwater extraction and treatment system in place (that effectively contains the groundwater and prevents the migration of LNAPL to the East Ditch), the potential for future groundwater impacts on surface water in the absence of the Plant B system is the scenario addressed by the remedial alternatives for the East Ditch surface water.

2.3 Identification and Screening of Technologies and Process Options

This section identifies and screens remedial technologies using the process outlined in the NCP and USEPA RI/FS guidance (USEPA, 1988b and 1990). Technologies are first identified to attain the remedial action objectives established in Section 2.1 and to correspond to the categories of general response actions described in Section 2.2. Demonstrated performance of each technology for Site contaminants and conditions is considered during technology identification. The result is a list of potential remedial technologies that are then screened based on their applicability to site- and waste-limiting characteristics. The purpose of the screening is to produce a list of suitable technologies that can then be assembled into remedial alternatives capable of mitigating actual or potential risks at the Site. A list of potential technologies representing a range of general response actions was considered to develop the remedial alternatives.

2.3.1 Identification and Screening of Technologies

Categories of remedial technologies and specific process options were identified for each of the RAOs based on a review of literature, vendor information, performance data, and experience in developing other FSs under CERCLA. Process options considered potentially applicable to attaining the remedial response objectives were selected for screening.

The technology screening process reduces the number of potentially applicable technologies and process options by evaluating factors that may influence their effectiveness and implementability. This overall screening is consistent with guidance for performing an FS under CERCLA (USEPA, 1988b).

The screening process assesses each technology or process option for its effectiveness and implementability with regard to site-specific conditions, known and suspected contaminants, and affected environmental media. The effectiveness evaluation focuses on: (1) whether the technology is capable of handling the estimated areas or volumes of media and meeting the contaminant reduction goals identified in the RAOs; (2) the effectiveness of the technology in protecting human health and the environment during the construction and implementation phase; and (3) how proven and reliable the technology is with respect to contaminants and conditions at the OCSS. Implementability encompasses both the technical and administrative feasibility of implementing a technology.

Waste-limiting characteristics primarily establish the effectiveness and performance of a technology; site-limiting characteristics affect implementability of a technology. Waste-limiting characteristics consider the suitability of a technology based on contaminant types, individual compound properties (e.g., volatility, solubility, specific gravity, adsorption potential, and biodegradability), and interactions that may occur between mixtures of compounds (e.g., chemical reactions or increased solubility). Site-limiting characteristics consider the effect of site-specific physical features on the implementability of a technology, including topography, buildings, underground utilities, available space, and proximity to sensitive operations. Technology screening based on waste- and site-limiting characteristics serves a twofold purpose of screening out technologies whose applicability is limited by site-specific waste or site considerations, while retaining as many potentially applicable technologies as possible. At this stage in the process, relative costs are considered to eliminate technologies that are substantially less cost-effective.

2.3.2 Evaluation of Technologies and Selection of Representative Technologies

The following subsections summarize the technology screening process. The retained technologies/process options may be used alone or integrated with other technologies to develop remedial alternatives.

2.3.2.1 Upland Soils Technology Screening Summary

Table 2.3-1 presents the technology screening for upland soils. Technologies and process options judged ineffective or not implementable were not retained. The retained technologies and process options are those considered most suitable for remediation of TMPs, chromium, and BEHP in soil at the OCSS.

The following paragraphs summarize the results of technology screening for TMPs in OU1 soil.

Institutional Controls. Technologies identified that may be used as components of remedial alternatives to provide institutional controls are Notice of Activity and Use Limitations (NAULs) and environmental monitoring. If institutional controls are incorporated as part of the selected remedy, they will be written in a manner that is specific to the required actions (e.g., installation of vapor barriers or implementation of health and safety plans) and will confer rights for enforcement.

Containment. Capping/soil cover technologies were retained to provide a surface barrier to prevent ecological receptor exposure to chromium- and/or BEHP-impacted soil.

Treatment. Air sparging (AS)/soil vapor extraction (SVE) was retained as a viable in-situ treatment technology for TMPs in shallow soil. An AS/SVE system was previously and successfully implemented at the Site for remediation of TMPs at the adjacent extractable petroleum hydrocarbon (EPH) / volatile petroleum hydrocarbon (VPH) Area. Monitoring of the extracted soil vapor provides a direct measure of remediation progress. Installation of subsurface vapor barriers or construction of sub-slab ventilation or depressurization systems was also retained for addressing TMPs in soils associated with future buildings at the Site that might be constructed over an area with potential VI concerns.

Solidification/stabilization was not retained as a stand-alone technology but was retained as a viable technology that may be used in conjunction with other technologies, such as excavation and off-site disposal.

In-situ thermal treatment was retained as a viable in-situ treatment technology for TMPs in shallow soil. For example, steam-enhanced thermal extraction may be effective at treating TMPs in soil.

In-situ chemical oxidation could be effective at treating TMPs in soil; however, providing adequate contact of the reagents with the capillary fringe smear zone and control of reagent migration toward East Ditch would make this technology more difficult to implement and less certain.

Ex-situ low temperature thermal treatment is viable for treating TMPs; however, unacceptable short-term exposure risks related to excavation of TMP-impacted soil and releasing volatile organic compounds resulted in this technology being eliminated from further consideration.

Removal. Mechanical excavation was retained as a viable technology that may be used in conjunction with ex-situ treatment or off-site disposal. The area TMP-impact is immediately adjacent to Eames Street and the Massachusetts Bay Transportation Authority commuter rail line and would be subject to fugitive emissions during excavation, which would need to be accounted for in development of remedial alternatives.

Disposal. Off-site disposal was retained for potential use in conjunction with removal of impacted soil by excavation.

2.3.2.2 Wetland Soil and Sediment Technology Screening Summary

Table 2.3-2 presents the technology screening for areas of wetland soil and sediment. Technologies and process options judged ineffective or not implementable were not retained. The retained technologies and process options are those considered most suitable for remediation of wetland soil and sediment.

The following paragraphs summarize the results of technology screening for wetland soil and sediment.

Institutional Controls. The only technology identified that may be used as a component of remedial alternatives to provide institutional controls is environmental monitoring. NAULs are not retained as they would not be effective in reducing ecological risk.

Containment. Capping technologies were not retained as installation of any type of capping system would negatively affect South Ditch and would destroy the existing wetland ecological habitat. The limited depth of stream flow (several inches) would make lining the ditch impractical.

Treatment. Solidification/stabilization was retained as a potentially viable technology to be implemented in conjunction with removal of soil and sediment by excavation. Some of the excavated material may be characterized as hazardous waste due to chromium concentrations and therefore may require stabilization or solidification prior to disposal in order to meet the disposal facility’s operating permit requirements. In-situ solidification/stabilization was not retained because it would be difficult to implement and would destroy the existing ecological habitat.

In-situ treatment technologies were not retained. For example, monitored natural recovery was eliminated because of the relatively low stream flow, shallow water depth and sediment deposition rate. Enhanced bioremediation was eliminated because it is not effective for the COCs (e.g., chromium). Chemical oxidation was eliminated because it is difficult to implement in surface soil and sediment and would alter the oxidation state of chromium.

Removal. Mechanical excavation was retained as a viable technology for removal of wetland soil and sediment.

Disposal. Off-site disposal was retained as a viable remedial technology. Consolidation and on-site disposal was eliminated due to limited available space for constructing a disposal area, as well as difficultly in permitting an on-site disposal facility.

2.3.2.3 Surface Water Technology Screening Summary

Table 2.3-3 presents the technology screening for surface water. Two general approaches were considered: (1) intercepting and treating groundwater prior to it discharging to surface water, and (2) removal of chromium, ammonia, and benzo(a)pyrene from surface water. Technologies to accomplish these general approaches were evaluated so that the analysis was comprehensive notwithstanding the current observation that concentrations of both chromium and ammonia in groundwater and in surface water are decreasing. Because sampling has been limited, there is no trend data available for benzo(a)pyrene. Technologies and process options judged ineffective or not implementable were not retained. The retained technologies and process options are those considered most suitable for remediation of surface water.

The following paragraphs summarize the results of technology screening for surface water.

Institutional Controls. The only technology identified that may be used as a component of remedial alternatives to provide institutional controls is environmental monitoring. NAULs are not retained as they would not be effective in reducing ecological risk.

Removal. Groundwater extraction was retained as a technology that could be effective and implementable for removing groundwater prior to discharge to these ditches. Groundwater extraction could be used in conjunction with other remedial technologies.

Treatment. The In-situ Treatment general response action considered a Permeable Reactive Barrier (PRB) and Chemical Adsorption. Both technologies are considered somewhat effective; however, in-situ chemical adsorption was eliminated from further consideration due to implementation concerns. Installation of a PRB was retained for further consideration in alternative development.

The IAFS Report includes remedial alternatives to address groundwater hot spot contamination. These alternatives include groundwater extraction and treatment consisting of construction of a new on-site groundwater treatment plant. Using this new groundwater treatment plant to treat groundwater associated with East, South, and Off-Property West Ditch has been retained as a viable treatment option for surface water.

3.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

In this section, alternatives are developed to meet the RAOs presented in Subsection 2.0, using the general response actions identified in Subsection 2.2 either singly or in combination. Remedial alternatives are typically then screened with respect to the criteria of effectiveness, implementability, and cost to meet the requirements of CERCLA and the NCP (40 CFR 300.430(e)(7)).

3.1 Alternative Screening Criteria

The objective of the alternative screening step is to eliminate impractical alternatives or higher cost alternatives (i.e., order of magnitude cost differences) that provide little or no increase in effectiveness or implementability over their lower-cost counterparts. The effectiveness, and implementability, and cost criteria used for screening the alternatives are discussed in the following paragraphs.

Effectiveness. This criterion focuses on the degree to which an alternative reduces toxicity, mobility, or volume through treatment, minimizes residual risks and affords long-term protection, complies with ARARs and minimizes short-term impacts. The NCP indicates that both short- and long-term aspects of effectiveness should be considered. Short-term is considered to be the construction and implementation period, while long-term begins once the remedial action is complete and RAOs have been met. Short-term effectiveness considerations include the effects of the alternatives during the construction and implementation period, the alternative's ability to meet RAOs, and the relative timeframe required to achieve RAOs. Long-term effectiveness considers the magnitude of the remaining residual risk because of residual contaminant sources, and the adequacy and reliability of specific technical components and control measures to maintain compliance with RAOs over the life of the remediation. Alternatives that do not meet the RAOs are eliminated from further consideration.

Implementability. Each alternative is also evaluated in terms of technical and administrative feasibility. In the assessment of short-term technical feasibility, availability of a technology for construction or mobilization and operation, as well as compliance with action-specific ARARs during the remedial action, are considered. Long-term technical feasibility considers the ease of operation and maintenance, technical reliability, the ease of undertaking additional remedial actions, and the degree of monitoring or controls for residuals and untreated wastes. Administrative feasibility for implementing a given technology addresses the ability to obtain approvals from pertinent offices and agencies for off-site activities, the availability of treatment storage and disposal services, and the commercial availability of required services and trained specialists or operators. Alternatives that are technically or administratively infeasible or that would require equipment, specialists, or facilities that are not available within a reasonable timeframe may be eliminated from further consideration (NCP, 40 CFR 300.430(e)(7)).

Costs. This criterion considers the costs of construction and long-term costs to operate and maintain the alternatives. As noted in USEPA guidance, the overall goal of the remedy selection process is to remediate contaminated sites to the maximum extent practicable, which requires a co-equal mandate for remedies to be cost-effective (USEPA, 1988b). Costs that are grossly excessive compared to the overall effectiveness of alternatives may be considered as one of several factors used to eliminate alternatives. Alternatives providing effectiveness and implementability similar to that of another alternative by employing a similar method of treatment or engineering control, but at greater cost, may also be eliminated (NCP, 40 CFR 300.430(e)(7)).

This section does not formally evaluate costs. Rather, based on knowledge of relative costs, professional judgment is used to identify the relative cost-effectiveness of each alternative. Detailed cost evaluations will be performed as part of the detailed evaluation of those alternatives passing the alternative screening process.

The No Action Alternative is not evaluated according to the screening criteria; it will pass through screening to be evaluated during the detailed analysis as a baseline for other retained alternatives (USEPA, 1988b). Actions taken to limit potential for exposure (e.g., institutional and other minimal actions) are identified as Limited Action alternatives in accordance with guidance (USEPA, 1988b, page 4-7 footnote 5 and page C-6) and the NCP (USEPA, 1990).

3.2 Identification and Development of Alternatives

Based on the screening of technologies presented in Subsection 3.2 and **Tables 2.3-1 through 2.3-3**, the following is a summary of technologies and process options that have been retained for each of the RAOs for development of composite remedial alternatives.

<u>TMPs in Soil</u>

Alternative TMP 1: No Action
Alternative TMP 2: Limited Action (Institutional Controls, including Vapor Intrusion Evaluations or Vapor Barriers and/or Sub-Slab Depressurization Systems [SSDSs])
Alternative TMP 3: AS/SVE
Alternative TMP 4: In-Situ Thermal Treatment
Alternative TMP 5: Excavation and Off-Site Disposal

Upland Soil

Alternative Soil 1: No Action
Alternative Soil 2: Cover Systems
Alternative Soil 3: Excavation (0-1 ft) and Cover Systems
Alternative Soil 4: Excavation (0-10 ft) and Off-Site Disposal

Wetland Soil and Sediment

Alternative WSS 1: No Action
Alternative WSS 2: Excavation and Off-Site Disposal

Surface Water

Alternative SW 1: No Action
Alternative SW 2: Limited Action – Surface Water and Groundwater Monitoring
Alternative SW 3: Groundwater Extraction and Treatment
Alternative SW 4: Targeted Groundwater Extraction and Treatment
Alternative SW 5: PRB
Alternative SW 6: Targeted Approach for PRB Installation

3.2.1 Remedial Alternatives for Trimethylpentenes (TMPs) in Soil

This section summarizes the remedial alternatives for TMPs in soil.

3.2.1.1 Alternative TMP 1: No Action

The No Action Alternative does not include any remedial action components to reduce, control, or eliminate potential risks from exposure to contaminated soil or VI. The No Action Alternative provides a baseline for comparison with the other developed alternatives as required by CERCLA and the NCP.

3.2.1.2 Alternative TMP 2: Limited Action (Institutional Controls, including Vapor Intrusion Evaluations or Vapor Barriers and/or Sub-Slab Depressurization Systems)

TMPs in soil are not associated with any current VI pathway because VI does not present a risk to occupants of existing buildings at the OCSS. However, TMPs in soil at various locations across the Site could pose a potential VI risk for future indoor workers and building occupants.

This alternative would include institutional controls that may be implemented through measures that may include, but are not limited to, a local town ordinance, an NAUL or a Grant of Environmental Restriction and Easement (GERE), and modifications to the existing deed covenant, which currently provides restrictions on future use and activities, to: 1) include language necessary to comply with USEPA's legal/enforcement requirements, and 2) include language to address potential VI concerns associated with future buildings that may be constructed on the Property. The institutional controls would prevent excavation and require vapor intrusion evaluations or effective engineering controls that are commonly employed to mitigate VI concerns. These engineering controls would include incorporating vapor barriers and/or SSDSs into the design and construction of future building foundations.

3.2.1.3 Alternative TMP 3: AS/SVE

This alternative would include installation of AS and SVE wells similar to the AS/SVE system previously installed in the vicinity of the former Plant B (EPH/VPH area) to treat vadose zone soils and soils within the capillary fringe impacted by TMPs. The AS/SVE system would be installed over the 23,000 square foot area in the vicinity of EA7 near Plant B, the 5,000 square foot area at EA-3, and the 2,500 square foot area associated with Lake Poly (EA1) where elevated levels of TMPs have been detected in soil. The system would likely operate for up to five years consistent with the duration of operations at the former EPH/VPH area.

3.2.1.4 Alternative TMP 4: In-Situ Thermal Treatment

This alternative involves steam-enhanced extraction using injection points and extraction wells to treat areas of elevated TMP concentrations in soil at three areas of the OCSS: Plant B and EA-7, EA-3, and the Lake Poly Area (EA-1). This alternative would target a 10-foot thick zone that straddles the water table at approximately 8 feet bgs. Conveyance piping would connect the three treatment areas to a central location near Plant B where the treatment system would be located. The central location would contain the treatment system equipment and the propane tanks that would provide fuel for steam generation.

3.2.1.5 Alternative TMP 5: Excavation and Off-Site Disposal

This alternative involves excavation and off-site disposal of areas of elevated TMP concentrations in subsurface soil in the vicinity of Plant B and EA-7, EA-3, and the Lake Poly Area (EA-1). This alternative assumes soil within these areas would be excavated down to and including the 5-foot thick smear zone that straddles the water table at approximately 8 feet bgs. This alternative conservatively assumes excavation to an overall depth of 12 feet. This alternative also assumes that some of the excavated soil would be stabilized on-site prior to off-site disposal.

3.2.2 Remedial Alternatives for Upland Soil

This section summarizes the remedial alternatives for upland soil.

3.2.2.1 Alternative Soil 1: No Action

The No Action Alternative does not include any remedial action components to reduce, control, or eliminate potential risks from exposure to contaminated soil. The No Action Alternative provides a baseline for comparison with the other developed alternatives as required by CERCLA and the NCP.

3.2.2.2 Alternative Soil 2: Cover Systems

This alternative involves placement of a cover system over areas of upland soil with elevated concentrations of Site contaminants above PRGs, combined with institutional controls to prevent disturbance or excavation in areas that are covered. The purpose of the cover is to prevent ecological receptor exposure to soil with chromium and/or BEHP at concentrations above the upland soil PRGs of 1,000 mg/kg for chromium and 3 mg/kg for BEHP. The cover would consist of either a 1-foot soil layer or a 3-inch layer of asphalt pavement. Areas that are already inaccessible because they are under buildings or are covered with competent concrete or asphalt would be maintained without additional cover. However, if buildings or competent concrete/asphalt cover systems are removed during redevelopment activities, the covers would need to be replaced with soil, asphalt, or other appropriate building materials pending redevelopment plans.

3.2.2.3 Alternative Soil 3: Excavation (0-1 ft) and Cover Systems

This alternative involves a combination of limited excavation and covering of areas of upland soil with elevated concentrations of Site contaminants above PRGs, combined with institutional controls to prevent disturbance or excavation in areas that are covered. The purpose of the combined limited excavation and covering system is to prevent ecological receptor exposure to soil with chromium and/or BEHP at concentrations above the upland soil PRGs of 1,000 mg/kg for chromium and 3 mg/kg for BEHP. Impacted soil from 0-1 feet would first be excavated, and the backfilled to cover deeper soils (>1 foot) with either a 1-foot soil layer or a 9-inch soil layer and 3-inch layer of asphalt pavement.

No additional physical remediation activities would be necessary for areas of chromium and/or BEHP in upland soil from 1-10 feet because the soil COC concentrations in these areas from 0-1 foot are already below the upland soil PRGs and/or are assumed to be below the PRGs based on the proposed pre-design investigation results. Therefore, this existing soil provides the 0-1 foot soil cover over the subsurface soil contamination.

3.2.2.4 Alternative Soil 4: Excavation (0-10 ft) and Off-Site Disposal

This alternative involves excavation and off-site disposal of areas of upland soil with elevated concentrations of Site contaminants above PRGs, including chromium and/or BEHP above the upland soil PRGs of 1,000 mg/kg for chromium and 3 mg/kg for BEHP. The purpose of this alternative is to prevent ecological receptor exposure to soil with chromium and/or BEHP at concentrations above the PRGs. Based on available upland soil analytical data, the majority of PRG exceedances for chromium and BEHP in upland soils is generally limited to approximately 8 feet bgs. The excavations would be backfilled with soil of appropriate quality. The surface material of the completed excavations would generally match pre-excavation conditions.

3.2.3 Remedial Alternatives for Wetland Soil and Sediment

This section summarizes the remedial alternatives for areas of wetland soil and sediment.

3.2.3.1 Alternative WSS 1: No Action

The No Action Alternative does not include any remedial action components to reduce, control, or eliminate potential risks from exposure to contaminated sediment or wetland soil. The No Action Alternative provides a baseline for comparison with the other developed alternatives as required by CERCLA and the NCP.

3.2.3.2 Alternative WSS 2: Excavation, Stabilization, and Off-Site Disposal

This alternative involves excavation and off-site disposal of areas of wetland soil and sediment with concentrations of Site contaminants above the PRGs, including chromium and/or BEHP above the established PRGs of 600 mg/kg (soil) and 100 mg/kg (sediment) for chromium, and 20 mg/kg (soil) and 100 mg/kg (sediment) for BEHP. This alternative also includes excavation and off-site disposal of Off Property West Ditch sediment, Upper and Lower South Ditch sediment, Central Pond sediment, and EA4 and EA5 surface soils that exceed PRGs for chromium and/or BEHP.

The purpose of this alternative is to prevent ecological receptor exposure to soils and sediments with chromium and/or BEHP concentrations above the respective PRGs. Based on available wetland soil analytical data, the majority of PRG exceedances for chromium and/or BEHP are limited to approximately 1-foot bgs. Therefore, remediation areas would be excavated to a depth of 1-foot bgs. Residual wetland soils below 1 foot that exceed PRGs will be left in place and an institutional control will be implemented to prohibit excavation or disturbance of these soils. The excavations would be backfilled with appropriate soil that had similar properties as the excavated soil, or a compensatory wetland mitigation will need to be completed.

3.2.4 Remedial Alternatives for Surface Water

This section summarizes the remedial alternatives for surface water.

3.2.4.1 Alternative SW 1: No Action

The No Action Alternative does not include any remedial action components to reduce, control, or eliminate potential risks from exposure to contaminated surface water. The No Action Alternative provides a baseline for comparison with the other developed alternatives as required by CERCLA and the NCP.

3.2.4.2 Alternative SW 2: Limited Action – Surface Water and Groundwater Monitoring

This alternative consists of long-term semi-annual monitoring of monitoring wells and surface water sampling points. This alternative would consist of semi-annual groundwater and surface water monitoring and reporting, and 5-Year Reviews.

3.2.4.3 Alternative SW 3: Groundwater Extraction and Treatment

This alternative would include installation of a series of groundwater extraction wells at upstream locations associated with South Ditch, and a series of groundwater extraction wells along East Ditch and the Off-PWD. Extracted groundwater would be conveyed to the treatment plant proposed to be constructed as part of the groundwater remediation alternatives presented in the IAFS. The treated groundwater would then be discharged to surface drainage; some discharged to the northern portion of East Ditch and some being discharged to the upstream portion of South Ditch.

3.2.4.4 Alternative SW 4: Targeted Groundwater Extraction and Treatment

The majority of elevated concentrations of chromium and ammonia discharging to South Ditch occur near the weir and the upstream portion of South Ditch. In addition, benzo(a)pyrene is present in the off-PWD at concentrations above the PRG. This alternative includes groundwater extraction and treatment targeted to address groundwater that discharges to this portion of South Ditch and to the off-PWD. Extracted groundwater would be conveyed to the treatment plant proposed to be constructed as part of the groundwater remediation alternatives presented in the IAFS. The treated groundwater would then be discharged to the upstream portion of South Ditch.

3.2.4.5 Alternative SW 5: PRB

This alternative would include installation of a PRB along the length of South Ditch and along the west side of East Ditch from just south of Plant B downstream to just south of the confluence with South Ditch and the Ephemeral Drainage. Reactive materials for the PRB would consist of zeolites to treat ammonia and activated carbon to treat chromium. If it is determined that benzo(a)pyrene is present in groundwater discharging to the off-PWD, the PRB would be installed to address benzo(a)pyrene where applicable. The PRB would be installed to the weathered bedrock surface and extend to ground surface.

3.2.4.6 Alternative SW 6: Targeted Approach for PRB Installation

The majority of elevated concentrations of chromium and ammonia discharging to South Ditch occurs near the weir and the upstream portion of South Ditch. This alternative includes installation of a PRB to address groundwater that discharges to this portion of South Ditch. Reactive materials for the PRB would consist of zeolites to treat ammonia and activated carbon to treat chromium. If it is determined that benzo(a)pyrene is present in groundwater discharging to the off-PWD, the PRB would be installed to address benzo(a)pyrene where applicable. The PRB would be installed to the weathered bedrock surface and extend to ground surface.

3.3 Screening of Alternatives

During this step of the FS process, the alternatives that have been developed are screened against the effectiveness, implementability, and cost criteria as described in Subsection 4.1. The objective of the alternative screening step is to eliminate impractical or economically infeasible alternatives (i.e., order of magnitude cost differences when compared to return on investments) that provide little or no increase in effectiveness or implementability over their lower-cost counterparts. The alternatives retained during this step are then carried through a detailed evaluation.

3.3.1 Remedial Alternatives for TMPs in Soil

This section presents the screening of remedial alternatives for TMPs in soil.

3.3.1.1 Alternative TMP 1: No Action

The No Action Alternative does not include any remedial action components. The No Action Alternative provides a baseline for comparison with the other developed alternatives as required by CERCLA and the NCP.

3.3.1.2 Alternative TMP 2: Limited Action (Institutional Controls, including Vapor Intrusion Evaluations or Vapor Barriers and/or Sub-Slab Depressurization Systems)

This alternative would include institutional controls that may be implemented through measures that may include, but are not limited to, a local town ordinance, an NAUL or a GERE, and modifications to the existing deed covenant, which currently provides restrictions on future use and activities, to: 1) include language necessary to comply with USEPA's legal/enforcement requirements, and 2) include language to address potential VI concerns associated with future buildings that may be constructed on the Property. The institutional controls would prevent excavation and require vapor intrusion evaluations or effective engineering controls that are commonly employed to mitigate VI concerns. These engineering controls would include incorporating vapor barriers and/or SSDSs into the design and construction of future building foundations.

This alternative would be effective by providing protection to occupants and workers in future buildings that may be constructed in the area where elevated levels of TMPs have been detected. The components of this alternative are commonly used to address VI concerns and are readily implemented. This alternative would have a low relative cost. This alternative is retained for detailed analysis.

3.3.1.3 Alternative TMP 3: AS/SVE

This alternative includes installation and operation of an AS/SVE system installed in the approximately 23,000 square foot area in the vicinity of EA7 near Plant B, the 5,000 square foot area associated with EA3, and the 2,500 square foot area associated with Lake Poly (EA1) where elevated levels of TMPs have been detected in subsurface soil.

This alternative would be effective by providing a reduction in the toxicity, mobility, or volume of contaminants. The proposed AS/SVE system is similar to that previously installed in the EPH/VPH area to address soil at and near the water table impacted by TMPs. This alternative can be readily implemented and has a moderate relative cost. This alternative is retained for detailed analysis.

3.3.1.4 Alternative TMP 4: In-Situ Thermal Treatment

This alternative involves steam enhanced extraction using injection points and extraction wells to treat areas of elevated TMP concentrations in soil at three areas of the OCSS: Plant B and EA-7, EA-3, and the Lake Poly Area (EA-1). This alternative would target a 10-foot thick zone that straddles the water table at approximately 8 feet bgs. This alternative would be effective by providing a reduction in the toxicity, mobility, or volume of contaminants. This alternative can be readily implemented and has a high relative cost that may make this alternative cost-prohibitive. This alternative is retained for detailed analysis.

3.3.1.5 Alternative TMP 5: Excavation and Off-Site Disposal

This alternative involves excavation and off-site disposal of areas of elevated TMP concentrations in subsurface soil in the vicinity of Plant B and EA-7, EA-3, and the Lake Poly Area (EA-1). This alternative assumes soil within these areas would be excavated down to and including the 5-foot thick smear zone that straddles the water table at approximately 8 feet bgs. This alternative conservatively assumes excavation to an overall depth of 12 feet. This alternative also assumes that some of the excavated soil would be stabilized on-site prior to off-site disposal. This alternative would be effective by providing a reduction in the toxicity, mobility, or volume of contaminants. This alternative can be readily implemented and has a moderate relative cost. This alternative is retained for detailed analysis.

3.3.2 Remedial Alternatives for Upland Soil

This section summarizes the remedial alternatives for upland soil.

3.3.2.1 Alternative Soil 1: No Action

The No Action Alternative does not include any remedial action components. The No Action Alternative provides a baseline for comparison with the other developed alternatives as required by CERCLA and the NCP.

3.3.2.2 Alternative Soil 2: Cover Systems

This alternative involves placement of a cover system over areas of upland soil with elevated concentrations of Site contaminants above PRGs, combined with institutional controls to prevent disturbance or excavation in areas that are covered. The cover would consist of either a 1-foot soil layer or a 3-inch layer of asphalt pavement. Areas that are already inaccessible because they are under buildings or are covered with competent concrete or asphalt would be maintained without additional cover. This alternative would provide long-term effectiveness and permanence by providing a cover over impacted upland soil that exceeds ecological PRGs. The technologies used for this alternative are generally implementable, readily available, are sufficiently demonstrated for use at the Site, and have a moderate relative cost. This alternative is retained for detailed analysis.

3.3.2.3 Alternative Soil 3: Excavation (0-1 ft) and Cover Systems

This alternative involves a combination of limited excavation and covering of areas of upland soil with elevated concentrations of Site contaminants above PRGs, combined with institutional controls to prevent disturbance or excavation in areas that are covered. Impacted soil from 0-1 foot would first be excavated, and the area backfilled to cover deeper soils (>1 foot) with either a 1-foot soil layer or a 9-inch soil layer and 3-inch layer of asphalt pavement. This alternative would provide long-term effectiveness and permanence by replacing surficial impacted soil with cover material over remaining deeper impacted upland soil that exceeds ecological PRGs. The cover would prevent exposure by current and future ecological receptors to surface and subsurface soil containing Site contaminants above PRGs that would result in potential adverse impacts. The technologies used for this alternative are generally implementable, readily available, are sufficiently demonstrated for use at the Site, and have a moderate relative cost. This alternative is retained for detailed analysis.

3.3.2.4 Alternative Soil 4: Excavation (0-10 ft) and Off-Site Disposal

This alternative involves excavation and off-site disposal of areas of upland soil with elevated concentrations of Site contaminants above PRGs, including chromium and/or BEHP above the upland soil PRGs of 1,000 mg/kg for chromium and 3 mg/kg for BEHP. This alternative assumes that soils would be excavated to an average depth of 8 feet bgs. The excavations would be backfilled with soil of appropriate quality. This alternative would provide long-term effectiveness by permanently removing Site contaminants at concentrations above PRGs from upland soil areas. The technologies used for this alternative are generally implementable, readily available, are sufficiently demonstrated for use at the Site, and have a moderate to high relative cost. This alternative is retained for detailed analysis.

3.3.3 Remedial Alternatives for Wetland Soil and Sediment

This section presents the screening of remedial alternatives for areas of wetland soil and sediment.

3.3.3.1 Alternative WSS 1: No Action

The No Action Alternative does not include any remedial action components. The No Action Alternative provides a baseline for comparison with the other developed alternatives as required by CERCLA and the NCP.

3.3.3.2 Alternative WSS 2: Excavation, Stabilization, and Off-Site Disposal

This alternative involves excavation and off-site disposal of areas of wetland soil and sediment with concentrations of Site contaminants above PRGs, including chromium and/or BEHP above the established PRGs of 600 mg/kg (soil) and 100 mg/kg (sediment) for chromium, and 20 mg/kg (soil) and 100 mg/kg (sediment) for BEHP. This alternative also includes excavation and off-site disposal of Off-Property West Ditch sediment, Upper and Lower South Ditch sediment, Central Pond sediment, and EA4 and EA5 surface soils that exceed PRGs for chromium and/or BEHP. This alternative assumes that the remediation areas would be excavated to a depth of 1-foot bgs. Residual wetland soils below 1 foot that exceed PRGs will be left in place and an institutional control will be implemented to prohibit excavation or disturbance of these soils. The excavations would be backfilled with soil of appropriate quality that had similar properties as the excavated soil, or a compensatory wetland mitigation will need to be completed.

This alternative would provide long-term effectiveness by permanently removing Site contaminants at concentrations above PRGs from wetland soil and sediment areas to a depth of 1 foot bgs. The technologies used for this alternative are generally implementable, readily available, are sufficiently demonstrated for use at the Site, and have a moderate relative cost. This alternative is retained for detailed analysis.

3.3.4 Remedial Alternatives for Surface Water

This section presents the screening of remedial alternatives for surface water.

3.3.4.1 Alternative SW 1: No Action

The No Action Alternative does not include any remedial action components. The No Action Alternative provides a baseline for comparison with the other developed alternatives as required by CERCLA and the NCP.

3.3.4.2 Alternative SW 2: Limited Action – Surface Water and Groundwater Monitoring

Based on monitoring data presented in the SASRs, concentrations of ammonia and chromium in surface water have decreased over time since high concentrations were observed in 2008/2009. This alternative includes long-term monitoring of surface water and associated groundwater to evaluate COC concentrations relative to the established PRGs. Monitoring would continue to demonstrate that COC concentrations in surface water quality continues to decline and will meet the site-specific surface water PRGs.

This alternative assumes continued operation of Plant B and would be effective by continued monitoring of East Ditch and South Ditch surface water and associated groundwater to verify that COC concentrations continue to decline and that surface water PRGs are met. Although EPA has acknowledged that other potential sources of benzo(a)pyrene may be contributing to impacts to the off-PWD, the PRG for benzo(a)pyrene will be applied to this alternative. If the results of future investigations indicate that conditions at the Property are not the source of benzo(a)pyrene in the off-PWD, PAHs may be eliminated from the sampling regime. This alternative can be readily implemented and has a low relative cost. This alternative is retained for detailed analysis.

3.3.4.3 Alternative SW 3: Groundwater Extraction and Treatment

This alternative includes installation of a series of groundwater extraction wells at locations upgradient (west) of the weir at the upstream portion of South Ditch, parallel to the off-PWD, and one groundwater extraction well midway along South Ditch between the weir and discharge location where South Ditch meets East Ditch. The alternative also includes installation of a series of groundwater extraction wells along East Ditch from just south of Plant B downstream to just south of the confluence with South Ditch and the Ephemeral Drainage.

Extracted groundwater would be conveyed to the treatment plant proposed to be constructed as part of the groundwater remediation alternatives presented in the IAFS. The treated groundwater would then be discharged to surface drainage; some discharged to the northern portion of East Ditch and some being discharged to the upstream portion of South Ditch.

This alternative would be effective by providing a reduction in the toxicity, mobility, or volume of contaminants. This alternative can be readily implemented and has a moderate-high relative cost. This alternative is retained for detailed analysis.

3.3.4.4 Alternative SW 4: Targeted Groundwater Extraction and Treatment

The majority of elevated concentrations of chromium and ammonia discharging to the ditches occurs near the weir and the upstream portion of South Ditch. Benzo(a)pyrene is also present in off-PWD surface water at concentrations above the PRG. This alternative includes groundwater extraction and treatment targeted to address groundwater that discharges to this portion of South Ditch and the off-PWD.

This alternative includes installation of three groundwater extraction wells along the western Property boundary upstream of the weir and parallel to the off-PWD, and one groundwater extraction well to the north of South Ditch approximately midway between the weir and the confluence of East and South Ditch. Extracted groundwater would be conveyed to the treatment plant proposed to be constructed as part of the groundwater remediation alternatives. The treated groundwater would then be discharged to the upstream portion of South Ditch. This alternative would be effective by providing a reduction in the toxicity, mobility, or volume of contaminants. This alternative can be readily implemented and has a moderate relative cost. This alternative is retained for detailed analysis.

3.3.4.5 Alternative SW 5: PRBs

This alternative would include installation of PRBs along the length of South Ditch and along the west side of East Ditch from just south of Plant B downstream to just south of the confluence with South Ditch and the Ephemeral Drainage. Although the current design for this alternative does not include PRB installation adjacent to the off-PWD, if pre-design investigation and sampling indicate that groundwater impacted with benzo(a)pyrene emanating from the Property is impacting the off-PWD, PRBs will be extended to address these impacts. The PRBs would be installed using a continuous trench method, extending from just below ground surface to weathered bedrock. Sections of grouted sheet pile walls would also be used at some locations, as necessary, to funnel groundwater flow through the PRBs. Reactive materials for the PRBs would likely consist of a mixture of zeolites to treat ammonia and activated carbon to treat chromium. If necessary, where applicable the PRBs would be designed to address discharge of benzo(a)pyrene-impacted groundwater to the off-PWD. This alternative can be readily implemented and has a high relative cost that may make this alternative cost-prohibitive. This alternative is retained for detailed analysis.

3.3.4.6 Alternative SW 6: Targeted Approach for PRB Installation

The majority of elevated concentrations of chromium and ammonia discharging to South Ditch occurs near the weir and the upstream portion of South Ditch. This alternative includes installation of PRBs to address groundwater that discharges to this portion of South Ditch. Although the current design for this alternative does not include PRB installation adjacent to the off-PWD, if pre-design investigation and sampling indicate that groundwater impacted with benzo(a)pyrene emanating from the Property is impacting the off-PWD, PRBs will be extended to address these impacts.

This alternative would include construction of a PRB perpendicular to the direction of groundwater flow in the vicinity of the weir and upstream portion of South Ditch where contaminated groundwater flows laterally to and discharges to the ditch. Reactive materials for the PRBs would consist of a mixture of zeolites to treat ammonia and activated carbon to treat chromium. If necessary, where applicable the PRBs would be designed to address discharge of benzo(a)pyrene-impacted groundwater to the off-PWD. The PRBs would be installed from just below ground surface to the weathered bedrock surface. This alternative can be readily implemented and has a moderate relative cost. This alternative is retained for detailed analysis.

3.3.5 Screening of Alternatives Conclusions

Based on the screening of remedial alternatives in Subsections 3.3.1 through 3.3.3, the following alternatives by media have been retained for detailed analysis.

<u>TMPs in Soil</u>

Alternative TMP 1: No Action
Alternative TMP 2: Limited Action (Institutional Controls, including Vapor Intrusion Evaluations or Vapor Barriers and/or SSDSs)
Alternative TMP 3: AS/SVE
Alternative TMP 4: In-Situ Thermal Treatment
Alternative TMP 5: Excavation and Off-Site Disposal

<u>Upland Soil</u>

Alternative Soil 1: No Action
Alternative Soil 2: Cover Systems
Alternative Soil 3: Excavation (0-1 ft) and Cover Systems
Alternative Soil 4: Excavation (0-10 ft) and Off-Site Disposal

Wetland Soil and Sediment

Alternative WSS 1: No Action
Alternative WSS 2: Excavation and Off-Site Disposal

Surface Water

Alternative SW 1: No Action
Alternative SW 2: Limited Action – Surface Water and Groundwater Monitoring
Alternative SW 3: Groundwater Extraction and Treatment
Alternative SW 4: Targeted Groundwater Extraction and Treatment
Alternative SW 5: PRB
Alternative SW 6: Targeted Approach for PRB Installation

4.0 DETAILED ANALYSIS OF ALTERNATIVES

This section presents the detailed analysis of alternatives.

The composite remedial alternatives are evaluated below with respect to nine CERCLA criteria:

1. Overall protection of human health and the environment
2. Compliance with ARARs
3. Long term effectiveness and permanence
4. Reduction of toxicity, mobility, or volume through treatment
5. Short-term effectiveness
6. Implementability
7. Cost
8. State acceptance
9. Community acceptance

The remedial alternatives were evaluated for the first seven criteria and then compared with one another to identify their respective strengths and weaknesses. Two criteria, state and community acceptance, were not evaluated because they will be based on comments received and addressed by USEPA during the Record of Decision process, which includes the public comment period for the Proposed Plan.

Cost estimates for the remedial alternatives were prepared using USEPA RI/FS guidance (USEPA, 1988b) and FS cost estimating guidance (USEPA, 2000). The cost estimates include capital costs (where appropriate) and operation and maintenance (O&M) costs. Both total cost and present worth costs are provided. An annual discount rate of 7 percent (%) was applied to calculate present worth.

As discussed in Section 3.0, the development and evaluation of remedial alternatives are presented by media in this FS; that is, for TMPs in soil, upland soil, wetland soil and sediments, and surface water. CERCLA requires that a no action alternative be included as a baseline for comparison of the remedial alternatives. Because the components and evaluation of the no action alternative would be the same for each media addressed, the no action alternatives for each media addressed in this FS are discussed in Section 4.1. The remedial alternatives for TMPs in soil, upland soil, wetland soil and sediments, and surface water are presented in Sections 4.2, 4.3, 4.4, and 4.5, respectively.

4.1 Alternatives TMP 1, Soil 1, WSS 1, and SW 1: No Action

The No Action alternative for each media does not include remedial action components to reduce, control, or eliminate potential risks from exposure to contaminants in soil, sediment, and surface water. The No Action Alternative provides a baseline for comparison with the other developed alternatives as required by CERCLA and the NCP.

4.1.1 Overall Protection of Human Health and the Environment

The No Action Alternatives do not meet the RAOs and therefore are not protective of human health or the environment because the existing restrictions on future use and activities would not be maintained, and monitoring would not be conducted to evaluate potential future impacts to human health and the environment.

4.1.2 Compliance with ARARs

The No Action Alternatives do not comply with ARARs because without monitoring, achievement of RAOs will not be known.

4.1.3 Long-term Effectiveness and Permanence

The No Action Alternatives are not considered effective in the long term because no actions are included to address potential risks to human health and the environment, and no monitoring would be conducted to evaluate achievement of RAOs.

4.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

The No Action Alternatives do not include any actions to treat or remove contamination in Site media, and no monitoring would be conducted to evaluate any changes in contaminant toxicity, mobility, or volume.

4.1.5 Short-term Effectiveness

The No Action Alternatives are not considered effective in the short-term because no actions are included to address potential risks to human health and the environment.

4.1.6 Implementability

No measures are implemented as part of the No Action Alternatives.

4.1.7 Cost

The No Action Alternatives have no capital or maintenance costs.

4.2 TMPs in Soil Alternatives

This section presents the detailed analysis for the following remedial alternatives for TMPs in soil:

Alternative TMP 2: Limited Action (Institutional Controls, including Vapor Intrusion Evaluations or Vapor Barriers and/or SSDSs)
Alternative TMP 3: AS/SVE
Alternative TMP 4: In-Situ Thermal Treatment
Alternative TMP 5: Excavation and Off-Site Disposal

4.2.1 Alternative TMP 2: Limited Action (Institutional Controls, including Vapor Intrusion Evaluations or Vapor Barriers and/or SSDSs)

This alternative consists of institutional controls (ICs) to address potential VI concerns associated with future buildings that may be constructed on the Property in areas where elevated concentrations of TMPs have been detected in subsurface soil. These areas of TMP-impacted soil are shown on **Figure 4.2-1**. This alternative also consists of vapor intrusion evaluations or engineering controls which would include vapor barriers and/or SSDSs into the design and construction of future building foundations. The SSDS designs could be passive systems with an option to upgrade to an active system pending post construction monitoring.

Components of Alternative TMP 2

The scope of the alternative includes the following major components:

- Institutional controls
    - Vapor intrusion evaluations, or
    - Vapor barriers/SSDSs
- Five-year reviews

Overall Estimated Duration of the Alternative

Implementation of Institutional Controls and preparation of design requirements for potential vapor barriers and/or SSDSs to be installed on future buildings that may be constructed at the

Site are anticipated to take approximately one year to complete. This alternative also estimated costs for five-year reviews for 30 years.

Institutional controls

ICs would be implemented through measures that may include, but not limited to, a local town ordinance, a NAUL, a GERE, or deed covenant modifications, which would include language to address potential VI concerns associated with future buildings that may be constructed on the Property at locations where VI is a concern and confer rights for enforcement of such restrictions. This limited action component of the alternative would rely on vapor intrusion evaluations or effective engineering controls that are commonly employed to mitigate VI concerns. These engineering controls would include incorporating vapor barriers and/or SSDSs into the design and construction of future building foundations.

Vapor barrier/SSDS

As part of the ICs, engineering controls in the form of vapor barriers and/or SSDSs would be required to be incorporated into the design and construction of future building foundations in the vicinity of EA7, EA3, and the Lake Poly area (EA1) where elevated levels of TMPs have been detected in subsurface soil.

Final design requirements will depend on the size and type of the building to be constructed and will need to be determined if/when a building is proposed for the area. However, for the purpose of this FS, it is conservatively assumed that both a vapor barrier and an active SSDS would be necessary. It is also assumed that the footprint of the building would be equal to the full extent of EA7 – approximately 23,000 square feet. The extent of the vapor barrier and/or SSDS associated with EA3 and the Lake Poly area is approximately 5,000 square feet and 2,500 square feet, respectively, or a total area of approximately 30,500 square feet. Although the area of TMPs in EA3 is located between the Property boundary and East Ditch, and is not conducive to future building construction, this area is included for a vapor barrier and/or SSDS as a conservative approach in the context of this FS.

For the purposes of providing FS-level costing for this alternative we have assumed that the venting system will consist of collection piping or a collection geotextile laid into a layer of gravel. The collection vents are laid out in a grid over the surface area of the building foundation and connected to header pipes that vent the gasses outside the building footprint. A fabric or cushion layer would then be placed over the gravel/vent system to protect the vapor barrier from puncture. The vapor barrier would be laid next and can be applied as a sheet with seams sealed or as a spray-applied membrane. Another fabric or cushion layer would usually be placed on top of the barrier to protect it from puncture during foundation construction, and then the concrete foundation is installed on top of the system.

Five-year site review

CERCLA requires that any remedial action that results in contaminants remaining on-site at concentrations above those allowing for unlimited exposure and unrestricted use must be reviewed at least every five years. During five-year site reviews, an assessment is made as to whether the implemented remedy continues to be protective of human health and the environment, or whether the implementation of additional remedial action is appropriate. The USEPA document Comprehensive Five-Year Review Guidance (USEPA, 2001) provides guidance on the performance of five-year reviews. For cost estimating purposes, this alternative assumes five-year site reviews to be conducted for 30 years.

4.2.1.1 TMP 2 Overall Protection of Human Health and the Environment

TMPs in soil are not associated with any current VI pathway, because VI does not present a risk to occupants of existing buildings. ICs that would include language, which may be by modifying the existing deed covenant, to address potential VI concerns associated with future buildings that may be constructed on the Property and requiring vapor intrusion evaluations or engineering controls, such as vapor barriers and/or SSDSs, into the design and construction of future building foundations would be protective of potential future building occupants. Language would be provided such that these provisions are enforceable. Therefore, this alternative would achieve the RAO of mitigating potential impacts to public health resulting from subsurface-to-indoor air vapor intrusion into buildings at the Site.

4.2.1.2 TMP 2 Compliance with ARARs

The location-, chemical-, and action-specific ARARs that are applicable to the TMP alternatives are identified in **Tables 2.1-1 through 2.1-3**. The applicability of the individual ARARs with respect to each alternative, and how the alternative will comply with the ARARs is identified in the tables.

Potential, but unlikely, location-specific ARARs related to TMPs in soil include encountering endangered species, migratory birds, areas of critical environmental concern, and historical and/or archeological resources, as identified in **Table 2.1-1**. If any of these location-specific ARARs are identified, design and implementation of the remedy with comply with applicable federal and state regulations, No applicable or relevant and appropriate chemical-specific requirements have been identified for this alternative. However, Site-specific PRGs have been developed to comply with the "to be considered" criteria or guidance identified in the chemical-specific ARARs presented in **Table 2.1-2**, including but not limited to USEPA risk assessment guidance documents and Regional Screening Levels.

This alternative would be designed and implemented to comply with the action-specific ARARs identified in **Table 2.1-3**, including but not limited to, federal and state air emission standards. Engineering controls to address potential VI concerns in future buildings that may be constructed at the Site would be designed and constructed to comply with the identified action-specific ARARs, such as USEPA's Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air, which has been identified as a to be considered criteria. Engineering controls would also be employed to comply with RCRA standards applicable to generation, transportation, and storage of hazardous waste, as well as federal and state solid waste disposal regulations.

4.2.1.3 TMP 2 Long-term Effectiveness and Permanence

This alternative would include institutional controls that may be implemented through measures that may include, but are not limited to, a local town ordinance, an NAUL or a Grant of Environmental Restriction and Easement (GERE), and modifications to the existing deed covenant, which currently provides restrictions on future use and activities, to: 1) include language necessary to comply with USEPA's legal/enforcement requirements, and 2) include language to address potential VI concerns associated with future buildings that may be constructed on the Property. The institutional controls would prevent excavation and require vapor intrusion evaluations or effective engineering controls that are commonly employed to mitigate VI concerns. These engineering controls would include incorporating vapor barriers and/or SSDSs into the design and construction of future building foundations.

Implementation of Institutional Controls and preparation of design requirements for potential vapor barriers and/or SSDSs to be installed on future buildings that may be constructed at the Site are anticipated to take approximately one year to complete.

4.2.1.4 TMP 2 Reduction of Toxicity, Mobility, or Volume through Treatment

Engineering controls, such as vapor barriers and/or SSDSs, if implemented, would reduce the toxicity, mobility, or volume of TMPs in the vicinity of Plant B (EA7), EA3, and Lake Poly (EA1) where elevated levels of TMPs have been detected in subsurface soil.

The in-situ volume of TMP-impacted soil in the soil/groundwater smear zone (5-foot thick) is approximately 5,700 cubic yards (~10,000 tons). An estimated 6,200 pounds of TMPs are associated with the 10,000 tons of subsurface TMP-impacted soil.

This alternative involves vapor barriers and/or SSDSs for removal of vapors that would potentially enter future buildings. Although contaminants are permanently removed, this alternative is not addressing the source of contamination directly and therefore does not satisfy the statutory preference for treatment as a principal element.

4.2.1.5 TMP 2 Short-term Effectiveness

This alternative would include institutional controls that may be implemented through measures that may include, but are not limited to, a local town ordinance, an NAUL or a GERE, and modifications to the existing deed covenant, which currently provides restrictions on future use and activities, to: 1) include language necessary to comply with USEPA's legal/enforcement requirements, and 2) include language to address potential VI concerns associated with future buildings that may be constructed on the Property. The institutional controls would prevent excavation and require vapor intrusion evaluations or effective engineering controls that are commonly employed to mitigate VI concerns. These engineering controls would include incorporating vapor barriers and/or SSDSs into the design and construction of future building foundations.

Implementation of Institutional Controls and preparation of design requirements for potential vapor barriers and/or SSDSs to be installed on future buildings that may be constructed at the Site are anticipated to take approximately one year to complete.

4.2.1.6 TMP 2 Implementability

The major components of this alternative are Institutional Controls, vapor intrusion evaluations, and engineering controls to address potential VI concerns associated with future buildings that may be constructed. These actions can be readily implemented and are commonly used actions to address potential vapor intrusion concerns into potential future buildings that may be constructed at the Site.

4.2.1.7 TMP 2 Cost

The cost estimate for this alternative is presented in **Table 4.2-1** and includes the following major components:

- Institutional controls

- Vapor intrusion evaluations, or
- Vapor barriers/SSDSs
- Five-year reviews

Implementation of institutional controls and preparation of design requirements for potential vapor barriers and/or SSDSs to be installed on future buildings that may be constructed at the Site are anticipated to take approximately one year to complete. For cost estimating purposes, this alternative assumes five-year Site reviews to be conducted for 30 years.

The cost estimate for this alternative, presented in **Table 4.2-1**, is summarized as follows:

Alternative TMP 2: Limited Action (Institutional Controls, including Vapor Intrusion Evaluations or Vapor Barriers and/or SSDSs)	
Capital Cost	$165,000
O&M Cost	$30,000
Total Cost	$195,000
Net Present Worth	$175,000
Overall Alternative Duration	30 years

4.2.2 Alternative TMP 3: AS/SVE

This alternative includes installation and operation of an AS/SVE system installed in the approximately 23,000 square foot area in the vicinity of EA7 near Plant B, the 5,000 square foot area in EA3, and the 2,500 square foot area associated with Lake Poly (EA1) where elevated levels of TMPs have been detected in subsurface soil.

Components of Alternative TMP 3

The scope of the alternative includes the following major components:

- Institutional controls
- Pre-design investigations and design
- Installation of AS/SVE system
- Reporting
- Long-term O&M
- Verification sampling
- Five-year reviews

Overall Estimated Duration of the Alternative

The estimated duration of this alternative is summarized as follows:

• Pre-design and design	6 months
• System construction, installation, and start-up	6 months
• Remedial system O&M	5 years
• Verification sampling and reporting	6 months

This alternative assumes five-year reviews would be conducted for 30 years. Therefore, the overall duration of this alternative is 30 years.

Institutional controls

ICs would be implemented through measures that may include, but not limited to, a local town ordinance, a NAUL, or a GERE.

Pre-design investigation and designs

Pre-design studies would consist of a direct-push drilling program to confirm the limits of TMPs in soil and to assess subsurface radius of influence for the proposed AS and SVE locations. Ground penetrating radar (GPR) and air knife/soil vac would also be conducted to identify locations and help avoid subsurface utilities. The pre-design investigation results would be used to develop the design for the AS/SVE treatment system to be installed. The remedial design would include details and specifications for the AS/SVE wells, piping, and treatment system components, as well as specific system operating, monitoring, and maintenance requirements.

Installation of AS/SVE system

An AS/SVE system would be installed in three areas of the OCSS where elevated levels of TMPs have been detected in subsurface soil. It is assumed that some of the previous AS/SVE equipment used at the Site could be repurposed. The proposed AS/SVE system and the three treatment areas are shown on **Figure 4.2-2**, and are summarized as follows:

- Plant B and EA7; approximately 23,000 square feet; 9 AS and 20 SVE wells
- EA3 (near RR tracks); approximately 5,000 square feet; 2 AS and 3 SVE wells
- Lake Poly (EA1); approximately 2,500 square feet; 1 AS and 2 SVE wells

This alternative assumes that some of the previous AS/SVE system components could be re-purposed and upgraded, and new piping and instrumentation would be installed. The AS/SVE system is anticipated to operate for up to 5 years.

This alternative assumes that the treatment system would primarily consist of using the former AS/SVE system components and upgrading the as necessary. The location of the re-purposed treatment trailer (containing the blower, compressor, and other ancillary equipment) and the re-purposed vapor-phase GAC is shown on **Figure 4.2-2**.

Reporting

A Remedial Action Report would be prepared to document the remedial action, including but not limited to, installation, start-up, and initial operation of the AS/SVE system.

Long-term O&M

This alternative would include long-term O&M of the AS/SVE system, which is anticipated to continue for up to five years. O&M requirements would be identified in the remedial design. O&M is assumed to consist of one operator at a rate of 16 hours per week. A performance monitoring report would be prepared annually to document O&M of the AS/SVE system.

Verification sampling

A post-remediation sampling program would be conducted to confirm achievement of RAOs and PRGs associated with TMPs in soil. This sampling program would include a direct-push drilling program to collect soil samples from the treatment areas, and is assumed to be completed in three days. The verification sampling is assumed to be conducted in year six, and the results would be included in the second five-year review.

Five-year site review

CERCLA requires that any remedial action that results in contaminants remaining on-site at concentrations above those allowing for unlimited exposure and unrestricted use must be reviewed at least every five years. During five-year site reviews, an assessment is made as to whether the implemented remedy continues to be protective of human health and the environment, or whether the implementation of additional remedial action is appropriate. The USEPA document Comprehensive Five-Year Review Guidance (USEPA, 2001) provides guidance on the performance of five-year reviews. This alternative assumes the AS/SVE system would operate for 5 years, followed by verification sampling. For cost estimating purposes, this alternative assumes five-year site reviews to be conducted for 30 years.

4.2.2.1 TMP 3 Overall Protection of Human Health and the Environment

This alternative would be protective of human health and the environment by installing an AS/SVE system to treat TMPs in subsurface soil to prevent potential VI concerns associated with future buildings that may be constructed in the vicinity of Plant B and EA7, EA3, and Lake Poly (EA1), as well as addressing construction worker health and safety plan requirements. Therefore, this alternative would achieve the RAO of mitigating potential impacts to public health resulting from subsurface-to-indoor air vapor intrusion into buildings at the Site.

4.2.2.2 TMP 3 Compliance with ARARs

The location-, chemical-, and action-specific ARARs that are applicable to the TMP alternatives are identified in **Tables 2.1-1 through 2.1-3**. The applicability of the individual ARARs with respect to each alternative, and how the alternative will comply with the ARARs is identified in the tables.

Potential, but unlikely, location-specific ARARs related to TMPs in soil include encountering endangered species, migratory birds, areas of critical environmental concern, and historical and/or archeological resources, as identified in **Table 2.1-1**. If any of these location-specific ARARs are identified, design and implementation of the remedy with comply with applicable federal and state regulations,

No applicable or relevant and appropriate chemical-specific requirements have been identified for this alternative. However, site-specific PRGs have been developed to comply with the "to be considered" criteria or guidance identified in the chemical-specific ARARs presented in **Table 2.1-2**, including but not limited to USEPA risk assessment guidance documents and Regional Screening Levels.

This alternative would be designed and implemented to comply with the action-specific ARARs identified in **Table 2.1-3**, including but not limited to, federal and state air emission standards. Engineering controls to address potential VI concerns in future buildings that may be constructed at the Site would be designed and constructed to comply with the identified action-specific ARARs, such as USEPA's Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air, which has been identified as a to be considered criteria. Engineering controls would also be employed to comply with RCRA standards applicable to generation, transportation, and storage of hazardous waste, as well as federal and state solid waste disposal regulations.

4.2.2.3 TMP 3 Long-term Effectiveness and Permanence

This alternative would provide long-term effectiveness by installing and operating an AS/SVE system to address potential VI concerns associated with future buildings that may be constructed on the Property. O&M and post-remediation verification sampling would be conducted to verify achievement of PRGs and long-term protection of human health and the environment.

Completion of on-site activities from pre-design investigations through final verification sampling and reporting, are estimated to take approximately 6.5 years. For cost estimating purposes, this alternative assumes five-year Site reviews to be conducted for 30 years.

4.2.2.4 TMP 3 Reduction of Toxicity, Mobility, or Volume through Treatment

This alternative would involve installation and operation of an AS/SVE system would reduce the toxicity, mobility, or volume of TMPs in the vicinity of Plant B and EA7, EA3, and Lake Poly (EA1) where elevated levels of TMPs have been detected in subsurface soil.

The in-situ volume of TMP-impacted soil in the soil/groundwater smear zone (5-foot thick) is approximately 5,700 cubic yards (~10,000 tons). An estimated 6,200 pounds of TMPs are associated with the 10,000 tons of subsurface TMP-impacted soil.

This alternative involves AS/SVE for removal of contaminants, which is irreversible (i.e., the contaminants are permanently removed). Therefore, this alternative satisfies the statutory preference for treatment as a principal element.

4.2.2.5 TMP 3 Short-term Effectiveness

This alternative includes installation and operation of an AS/SVE system for treatment of TMPs in subsurface soil. This alternative would be protective of human health and the environment and would provide short-term effectiveness upon completion of construction-related activities and O&M of the proposed treatment system associated with this alternative, which is estimated to be approximately 6.5 years. Potential short-term risks to on-site workers involved in the remedial activities would be minimized by conducting the work in accordance with a site-specific health and safety plan (HASP). Potential short-term risks to the community would be addressed by minimizing dust, implementing an air monitoring program, and minimizing vehicular traffic associated with the remediation effort from traveling through residential areas.

4.2.2.6 TMP 3 Implementability

This alternative includes installation and operation of an AS/SVE system for treatment of TMPs in subsurface soil. The technologies used for this alternative are available and sufficiently demonstrated for use at the Site. The necessary equipment and materials are readily available.

This alternative involves operation of an AS/SVE system, which is generally implementable at the Site based on known hydrogeology and areas of impact. TMPs occur within the "smear zone" coincident with the annual high and low water table conditions and are readily treated by this alternative.

This alternative would use standard construction equipment, and the necessary equipment and materials to implement this alternative are readily available.

Pre-design investigation activities would include verification of the locations of subsurface utilities that may be present within the proposed treatment areas.

TMPs are highly volatile; therefore, an air monitoring program would be implemented to assess air emissions associated with the treatment system, and alert operators to make adjustments if emissions may impact nearby receptors.

4.2.2.7 TMP 3 Cost

The cost estimate for this alternative is presented in **Table 4.2-2** and includes the following major components:

- Institutional controls
- Pre-design investigations and design
- Installation of AS/SVE system
- Reporting
- Long-term O&M
- Verification sampling
- Five-year reviews

Completion of the on-site activities from pre-design investigations through final verification sampling and reporting, are estimated to take approximately 6.5 years. TMPs may remain in soil at concentrations that may not allow for unlimited use and unrestricted exposure. For cost estimating purposes, this alternative assumes five-year Site reviews to be conducted for 30 years.

The cost estimate for this alternative, presented in **Table 4.2-2**, is summarized as follows:

Alternative TMP 3: AS/SVE	
Capital Cost	$480,000
O&M Cost	$454,000
Total Cost	$934,000
Net Present Worth	$816,000
Overall Alternative Duration	30 years

4.2.3 Alternative TMP 4: In-Situ Thermal Treatment

This alternative uses steam enhanced extraction, consisting of steam injection points and dual phase extraction wells, to treat areas of elevated TMP concentrations in the three areas where elevated TMP concentrations have been identified.

Other heating methods such as electrical resistance heating (ERH) and thermal conduction heating (TCH) were also considered during alternative development. ERH and TCH are often used when temperatures higher than the boiling point of water (100°C) are necessary for treatment, and/or when low permeability soils would limit the delivery of steam for heating. The soil in the proposed treatment areas are permeable sands and gravels, and the boiling point of TMPs is less than 100°C. Therefore, steam enhanced extraction was selected as a more feasible, cost-effective in-situ heating alternative.

The approximate remediation areas and conceptual layout are shown on **Figure 4.2-3**. The ISTT system would target steam injections over a 10-foot thick zone, from approximately 6 to 16 feet, which would straddle the approximate 8-foot deep water table. This configuration heats a volume of soil thicker than the anticipated 5-foot smear zone to reach the target temperature more efficiently and is assumed equal for each of the three proposed treatment areas. Due to continued pumping in the Plant B area to maintain a cone of depression in support of LNAPL recovery, the water table in the EA 3 area is approximately one foot lower in elevation than the other two treatment areas. However, for cost estimating purposes, the same assumption is used for all three areas, and the estimated costs are expected to be within the USEPA's FS cost range of +50% to -30%.

As shown on **Figure 4.2-3**, conveyance piping would connect the three treatment areas to a central location where the treatment system would be located. This central location would contain the treatment system equipment and the propane tanks that would provide fuel for steam generation.

Components of Alternative TMP 4

The scope of the alternative includes the following major components:

- Institutional controls
- Pre-design investigations and design
- Installation of steam injection points and extraction wells at the following areas:
    - Plant B and EA-7
    - EA-3 (near railroad tracks)
    - Lake Poly Area (EA-1)
- Installation of piping and treatment system
- O&M of treatment system, periodic monitoring, and reporting
- Five-year Site reviews

Overall Estimated Duration for the Alternative

The overall project duration is estimated to take approximately two years, summarized as follows:

• Pre-design and design	6 months
• Mobilization, construction, installation, and start-up	6 months
• Remedial system O&M	6 years
• Verification, dismantle system, demobilization and reporting	6 months

For cost estimating purposes, this alternative assumes five-year Site reviews to be conducted for 30 years.

Institutional controls

ICs would be implemented through measures that may include, but not limited to, a local town ordinance, a NAUL, or a GERE.

Pre-design investigations and design

Pre-design investigations would consist of a direct-push drilling program to confirm the limits of TMPs in soil and to assess subsurface radius of influence for the proposed injection points and extraction wells. Ground penetrating radar (GPR) and air knife/soil vac would also be conducted to identify locations and help avoid subsurface utilities. The results of the pre-design investigations would then be used to develop the design for the injection/extraction and treatment system to be installed. The remedial design would include details and specifications for the injection points, extraction wells, conveyance piping, and treatment system components. The design would also include specific remedial system operation, monitoring, and maintenance requirements.

Note that a pilot study is not recommended for this alternative. In lieu of a pilot study, the alternative would initially be implemented at the Lake Poly Area for a short period of time as an alternative effectiveness evaluation. Data obtained during this initial startup period would then be used to make any necessary adjustments before expanding the implementation and completing installation and treatment at the Plant B and EA3 areas.

Installation of injection points and extraction wells

The conceptual design completed for the purpose of developing cost estimates for this alternative assumes that injection points would be installed at approximately 20-foot spacing and dual phase extraction wells would be installed at approximately 40-foot spacing. The actual spacing would be determined during remedial design. The proposed injection points and extraction wells are shown on **Figure 4.2-3**, and are summarized as follows:

- Plant B and EA7 - Approximately 23,000 square foot (sf) area; 44 injection points and 21 extraction wells
- EA3 (near RR tracks) - Approximately 5,000 sf area; 5 injection points and 5 extraction wells
- Lake Poly Area (EA1) - Approximately 2,500 sf area; 4 injection points and 4 extraction wells

The injection points and extraction wells would be installed to address the smear zone that straddles the water table at approximately 8 feet bgs. The conceptual design assumes the injection/extraction system would target a 10-foot thick interval from approximately 6 to 16 feet bgs, including a 5-foot thick smear zone.

Installation of piping and treatment system

Piping would be installed to connect the three treatment areas to the centrally-located treatment system as shown on **Figure 4.2-3**. This piping is likely to be a combination of aboveground and subsurface installations depending on Site conditions and the presence of other existing subsurface structures or utilities. The final piping layout/configuration would be determined during remedial design. The treatment system would consist of trailer and/or skid-mounted components provided by an environmental remediation subcontractor, summarized as follows:

- Trailer containing the steam boiler system (8’x20’)
- Blower unit (8’x12’)
- Condenser unit (8’x20’)
- Water and vapor treatment units GAC (8’x20’)
- Influent and effluent holding tanks (6-foot diameter)
- Propane tanks (20’x70’)
- Support trailer (8’x40’)

A conceptual layout of the above-listed components of the temporary treatment plant are shown on **Figure 4.2-3**.

The treatment system components are anticipated to require an area of approximately 4,000 sf (approximately 50 feet by 80 feet). This includes storage space for ten 1,000-gallon propane tanks to allow fuel for a minimum of a one-week period to operate the steam injection portion of the alternative.

The treatment system components, specifications, and layout will be refined, as relevant, during remedial design.

O&M of treatment system

The specific system operation, monitoring, and maintenance requirements would be established during remedial design. The conceptual design of the injection/extraction and treatment system was developed in consultation with an environmental remediation contractor that specializes in this type of remedial system. Operation of the injection, extraction, and treatment system is estimated to be approximately 6 months. A system monitoring and performance report would be prepared to document O&M of the system.

The following provides an estimate of electrical and steam energy information for the remedial system:

Estimated steam power: 1,260 kilowatts (kW)
Estimated steam energy: 3,000,000 kW hours (kWh)
Estimated electrical energy for treatment equipment: 220,000 kWh
Estimated propane: usage: 192,000 gallons; 8,000 gallons per week for 6 months

A post-remediation verification sampling program would be conducted to confirm achievement of RAOs and PRGs for TMPs. After confirming the achievement of RAOs and PRGs, the treatment system would be decommissioned, and the aboveground components would be removed. A Remedial Action Report would be prepared to document the treatment system installation, startup, initial operational period, and post-remediation verification investigation results.

Five-year site review

CERCLA requires that any remedial action that results in contaminants remaining on-site at concentrations above those allowing for unlimited exposure and unrestricted use must be reviewed at least every five years. During five-year site reviews, an assessment is made as to whether the implemented remedy continues to be protective of human health and the environment, or whether the implementation of additional remedial action is appropriate. The USEPA document Comprehensive Five-Year Review Guidance (USEPA, 2001) provides guidance on the performance of five-year reviews. It is anticipated that this alternative will treat soil within the proposed areas to reduce TMP concentrations to below PRGs. However, TMPs may remain in soil at concentrations that may not allow for unlimited use and unrestricted exposure. Therefore, five-year site reviews will be conducted as required under CERCLA. For cost estimating purposes, this alternative assumes five-year reviews to be conducted for 30 years.

4.2.3.1 TMP 4 Overall Protection of Human Health and the Environment

This alternative would be protective of human health and the environment by using steam enhanced extraction to reduce TMP concentrations in subsurface soil in the vicinity of Plant B and EA-7, EA-3, and the Lake Poly Area (EA-1), thereby reducing potential risk and eliminating the exposure pathway to public health by removing the volatile contaminants from the soil/groundwater smear zone. In-situ treatment of TMP impacted soil in these three areas of the Site would also mitigate potential indoor air vapor intrusion into future buildings that may be constructed in these areas of the Site. Therefore, this alternative would achieve the RAO of mitigating potential impacts to public health resulting from subsurface-to-indoor air vapor intrusion into buildings at the Site.

4.2.3.2 TMP 4 Compliance with ARARs

The location-, chemical-, and action-specific ARARs that are applicable to the TMP alternatives are identified in **Tables 2.1-1 through 2.1-3**. The applicability of the individual ARARs with respect to each alternative, and how the alternative will comply with the ARARs is identified in the tables.

Potential, but unlikely, location-specific ARARs related to TMPs in soil include encountering endangered species, migratory birds, areas of critical environmental concern, and historical and/or archeological resources, as identified in **Table 2.1-1**. If any of these location-specific ARARs are identified, design and implementation of the remedy with comply with applicable federal and state regulations,

No applicable or relevant and appropriate chemical-specific requirements have been identified for this alternative. However, site-specific PRGs have been developed to comply with the "to be considered" criteria or guidance identified in the chemical-specific ARARs presented in **Table 2.1-2**, including but not limited to USEPA risk assessment guidance documents and Regional Screening Levels.

This alternative would be designed and implemented to comply with the action-specific ARARs identified in **Table 2.1-3**, including but not limited to, federal and state air emission standards and hazardous waste regulations related to the use of tanks and containers associated with the treatment system, as well as disposal requirements for waste materials generated during the remedial action.

This alternative involves steam enhanced extraction to treat elevated TMP concentrations in subsurface soil. Water and vapors associated with the extraction would be treated using GAC. Discharge of the treated vapors would comply with RCRA Air Emission Standards and Massachusetts Air Pollution Control Regulations, both of which have been identified as action-specific requirements for this alternative.

4.2.3.3 TMP 4 Long-term Effectiveness and Permanence

This alternative would provide long-term effectiveness by using steam enhanced extraction to permanently remove TMPs at concentrations above PRGs from the soil/groundwater smear zone. O&M and post-remediation sampling would be conducted to verify achievement of PRGs and long-term protection of human health and the environment.

In-situ treatment of TMP impacted soil would mitigate potential indoor air vapor intrusion into future buildings that may be constructed in these areas of the Site, thereby providing additional long-term effectiveness and permanence.

Steam enhanced extraction is a proven technology for treating VOCs such as TMPs in saturated soil and groundwater. This technology is a reliable remedy for reducing contaminant concentrations and the capture of fugitive gases.

Completion of the on-site activities from pre-design investigations through final verification sampling and reporting, are estimated to take approximately two years. Additionally, five-year reviews would be conducted for 30 years.

This alternative involves in-situ thermal treatment of TMPs associated with the soil/groundwater smear zone, which contains the highest concentrations of TMPs. The treatment system is anticipated to achieve approximately 99.5% mass removal, thereby resulting in minimal contamination remaining and minimal risk to receptors following completion of this alternative.

4.2.3.4 TMP 4 Reduction of Toxicity, Mobility, or Volume through Treatment

This alternative would involve using steam enhanced extraction to reduce TMP concentrations in subsurface soil in the vicinity of Plant B and EA-7, EA-3, and the Lake Poly Area (EA-1). In-situ treatment of TMPs in the soil/groundwater smear zone would reduce the toxicity, mobility, and volume of contaminants from the subsurface in these areas of the Site.

The in-situ volume of TMP-impacted soil in the soil/groundwater smear zone (5-foot thick) is approximately 5,700 cubic yards (~10,000 tons).

Steam enhanced extraction is anticipated to achieve approximately 99.5% mass removal. An estimated 6,200 pounds of TMPs are anticipated to be removed from 10,000 tons of subsurface soil over the course of six months of in-situ treatment.

This alternative involves in-situ treatment of soil using steam enhanced extraction and the removal of contaminants is irreversible (i.e., the contaminants are permanently removed). Therefore, this alternative satisfies the statutory preference for treatment as a principal element.

4.2.3.5 TMP 4 Short-term Effectiveness

This alternative involves steam enhanced extraction, which would be effective at removing TMPs from subsurface soil in the vicinity of Plant B and EA-7, EA-3, and the Lake Poly Area (EA-1). This alternative would be protective of human health and the environment and would provide short-term effectiveness upon completion of construction-related activities and O&M of the proposed treatment system associated with this alternative, which is estimated to be approximately two years. Potential short-term risks to on-site workers involved in the remedial activities would be minimized by conducting the work in accordance with a site-specific HASP. Potential short-tern risks to the community would be addressed by minimizing dust, implementing an air monitoring program, and minimizing vehicular traffic associated with the remediation effort from traveling through residential areas.

The remedial design would include specific requirements related to remedial system operation, monitoring, and maintenance. These monitoring requirements would be implemented to ensure adequate capture of contaminants. Additionally, an air monitoring program would be used to assess emissions and alert operators to make adjustments if emissions may impact nearby receptors.

4.2.3.6 TMP 4 Implementability

This alternative involves steam enhanced extraction, which is generally implementable at the Site based on known hydrogeology and areas of impact. TMPs occur within the "smear zone" coincident with the annual high and low water table conditions and are readily treated by the resulting steam and heat provided by this treatment alternative.

This alternative would use standard construction equipment augmented by specialized heating elements for the steam injection points. The necessary equipment and materials to implement this alternative are readily available.

Pre-design investigation activities would include verification of the locations of subsurface utilities that may be present within the proposed treatment areas. Some subsurface utilities may need relocation and/or protection due to subsurface heating.

The proposed treatment area associated with EA-3, located east of Plant B, is within the railroad right-of-way of an active line and adjacent to East Ditch. The installation and operation of this treatment system would require close coordination with the Massachusetts Bay Transportation Authority, which operates this active railroad line.

TMPs are highly volatile; therefore, an air monitoring program would be implemented to assess air emissions associated with the extraction and treatment system, and alert operators to make adjustments if emissions may impact nearby receptors.

The conceptual design developed for this FS is based on steam injection points installed at approximately 20-foot spacing and dual phase extraction wells installed at approximately 40-foot spacing. The actual spacing would be determined during the remedial design and radius of influence assessments. The actual locations of injection points and extraction wells may be adjusted based on existing structures, subsurface utilities, soil porosity, and pre-design investigation results. Similarly, the location of piping, which would likely include a combination of aboveground and underground piping, may be adjusted from that shown on **Figure 4.2-3** based on results of the pre-design investigation and subsequent remedial design.

As shown on **Figure 4.2-3**, the three treatment areas would be piped to a centrally-located treatment area. The proposed treatment area would include the treatment system, as well as propane storage tanks. This alternative is anticipated to be completed in approximately two years, at which time the aboveground components of the extraction and treatment system, along with the propane storage tanks, would be removed. Therefore, this alternative would not impact potential long-term redevelopment plans for the Site.

Propane would be used as fuel for the steam injection portion of the alternative. The estimated propane usage would be approximately 192,000 gallons over a six-month operational period, or approximately 8,000 gallons of propane per week. Therefore, ten 1,000-gallon propane tanks are proposed, which would provide fuel for one week of remedial system operation, plus 2,000 gallons in reserve so that only eight tanks would need to be filled on a weekly basis.

4.2.3.7 TMP 4 Cost

The cost estimate for this alternative is presented in **Table 4.2-3** and includes the following major components:

- Institutional controls
- Pre-design investigations and design
- Installation of injection points and extraction wells at Plant B and EA-7, EA-3, and Lake Poly Area (EA-1)
- Installation of piping and treatment system
- O&M of treatment system, periodic monitoring, and reporting
- Five-year Site reviews

Estimated Duration for the Alternative

The overall project duration is estimated to take approximately two years, summarized as follows:

- Pre-design and design — 6 months
- Mobilization, construction, installation, and start-up — 6 months
- Remedial system O&M — 6 years
- Verification, dismantle system, demobilization and reporting — 6 months

For cost estimating purposes, this alternative assumes five-year Site reviews to be conducted for 30 years. Costs associated with construction and operation of the injection points, extraction wells, and treatment system were provided by an environmental remediation contractor that specializes in this type of remedial system. Costs associated with pre-design investigations, verification sampling, and reporting are based on costs for similar projects.

The cost estimate for this alternative, presented in **Table 4.2-3**, is summarized as follows:

Alternative TMP 4: In-Situ Thermal Treatment	
Capital Cost	$3,952,000
O&M Cost	$1,626,000
Total Cost	$5,578,000
Net Present Worth	$5,452,000
Overall Alternative Duration	30 years

4.2.4 Alternative TMP 5: Excavation and Off-Site Disposal

This alternative involves excavation and off-site disposal of areas of elevated TMP concentrations in the vicinity of Plant B and EA-7, EA-3, and the Lake Poly Area (EA-1). The approximate remediation areas are shown on **Figure 4.2-4**. The alternative assumes soil within these areas would be excavated down to and including the 5-foot thick smear zone that straddles the water table at approximately 8 feet in depth. The alternative conservatively assumes excavation to an average depth of 12 feet within each remedial area, however these areas and depths will be refined during pre-design investigations. Soil from 0 to 7 feet bgs will be characterized, but is assumed to be suitable for use as backfill material. Soil from the smear zone generally from approximately 7 to 12 feet bgs will be shipped off-site for disposal. Please note that due to continued pumping in the Plant B area to maintain a cone of depression in support of LNAPL recovery, the water table in the EA 3 area is approximately one foot lower in elevation than the other two treatment areas. However, for cost estimating purposes, the same assumption is used for all three areas, and the estimated costs are expected to be within the USEPA's FS cost range of +50% to -30%. Therefore, the above assumptions apply to each of the three proposed excavation areas.

Components of Alternative TMP 5

The scope of the alternative includes the following major components:

- Institutional controls
- Pre-design investigations
- Excavation of TMP-impacted soil at the following areas
    - Plant B and EA-7
    - EA-3 (near RR tracks)
    - Lake Poly Area (EA-1)
- Excavation dewatering, as necessary

- Dewatering/stabilization of excavated soil, as necessary
- Off-site disposal of excavated soil
- Verification sampling
- Backfill and restoration
- Reporting
- Five-year Site reviews

Overall Estimated Duration for the Alternative

The overall project duration is estimated to take approximately one year, summarized as follows:

- Pre-design and design 3 months
- On-site remedial activities 4 months
- Verification and reporting 4 months

For cost estimating purposes, this alternative assumes five-year Site reviews to be conducted for 30 years.

Institutional controls

ICs would be implemented through measures that may include, but not limited to, a local town ordinance, a NAUL, or a GERE.

Pre-design investigations

Pre-design investigations would consist of a direct-push drilling program to confirm the limits of TMPs in soil that require remediation. For cost estimating purposes, the field effort for this investigation is anticipated to be completed in three days.

Excavation of TMP-impacted soil

The excavation limits would be based on the pre-design investigation results. For purposes of alternative evaluation, this alternative proposes the following areas to be excavated:

- Plant B and EA-7 - Approximately 23,000 square foot area
- EA-3 (near RR tracks) - Approximately 5,000 square foot area
- Lake Poly Area (EA-1) - Approximately 2,500 square foot area

The proposed remediation areas are shown on **Figure 4.2-4**. This alternative assumes that the vadose zone soil (0-7 feet bgs) would be characterized as suitable for re-use (e.g., TMP concentrations below PRGs), would be stockpiled, and reused as backfill material in the completed excavation areas. This alternative assumes that the smear zone soil (7 to 12 feet bgs) would be characterized as "contaminated" (e.g., TMP concentrations above PRGs), would be stabilized on-site, and shipped off-site for disposal as non-hazardous waste.

The volume of soil associated with this alternative is summarized as follows:

- Total estimated in-situ soil volume to be excavated is 13,555 cubic yards (cy)
- Estimated volume of soil to be reused as backfill is 7,907 cy
- Estimated volume of soil to be stabilized and disposed off-site is 5,648 cy (10,000 tons)

The estimated volume of soil to be treated on-site via stabilization (5,648 cy) is approximately 40% of the total estimated soil excavation volume (13,555 cy). Based on the available data, approximately 6,200 lbs of TMP is remaining at the Site and the entire mass is assumed to be excavated.

Due to the high volatility of TMPs and the close proximity to receptors and/or the general public, work associated with the smear zone soils is assumed to be conducted in an enclosed structure with negative air pressure and air treatment. Additionally, work may need to be conducted in Level C or Level B PPE, which would be determined based on a site-specific HASP to be prepared for this project.

Excavation dewatering

The depth of the proposed excavation areas is anticipated to be approximately 12 feet, with an average water table of approximately 8 feet bgs. To the extent possible, the proposed excavations would be conducted during times of low water table conditions to minimize the volume of saturated soil to be excavated. However, it is likely that excavation dewatering would be necessary to facilitate excavation to the required depth. It is anticipated that excavation dewatering would require pumping at ≤10 gpm. The extracted groundwater would be treated using a portable GAC water treatment system followed by discharge to surface water. Frac tanks would be used for temporary storage of dewatering fluids: one tank to store water prior to treatment and one tank to store treated water prior to discharge. The GAC water treatment system and frac tanks would likely be located near Plant B, as shown on **Figure 4.2-4**.

Dewatering/stabilization of excavated soil

This alternative assumes that all smear zone soil (7 to 12 feet bgs) would require stabilization to reduce the water content of the soil and to stabilize the TMP-impacted soil prior to off-site disposal. It is anticipated that recovered water would be captured and treated through the on-site treatment system or transported off-site for disposal as a non-hazardous waste. Soil would be stabilized using Portland cement, lime, or another suitable stabilizing agent. The estimated in-situ volume of soil anticipated to require stabilization is 5,648 cy, or approximately 40% of the total excavated soil volume.

Off-site disposal of excavated soil

As discussed in the preceding paragraph, approximately 5,648 cy of excavated soil would require on-site stabilization followed by off-site disposal as a non-hazardous waste. This would result in approximately 10,000 tons of stabilized soil being shipped off-site for disposal as non-hazardous waste.

Verification sampling

A post-remediation verification sampling program would be conducted to confirm achievement of RAOs and PRGs for TMPs. This sampling program would include collecting soil samples at the completed excavation limits and analyzing the samples for TMPs to verify TMP concentrations are below the established PRGs.

Backfill and restoration

This alternative assumes that soil overlying the smear zone (0-7 feet bgs) would be characterized as suitable for re-use. That is, TMP concentrations in this material is assumed to be below the established PRGs, and therefore, this overlying material (approximately 7,907 cy) would be used as backfill following excavation of the impacted areas. The remainder of the excavation areas would be backfilled with imported "clean" soil, followed by a 6-inch thick layer of crushed stone as a surface layer. The completed excavation areas would be backfilled to return the areas to original grades (i.e., pre-excavation ground surface elevations).

Reporting

A Remedial Action Report would be prepared to document the remedial action, including but not limited to the final excavation limits, on-site stabilization efforts, waste disposal, and verification sampling results.

Five-year site reviews

CERCLA requires that any remedial action that results in contaminants remaining on-site at concentrations above those allowing for unlimited exposure and unrestricted use must be reviewed at least every five years. During five-year site reviews, an assessment is made as to whether the implemented remedy continues to be protective of human health and the environment, or whether the implementation of additional remedial action is appropriate. The USEPA document Comprehensive Five-Year Review Guidance (USEPA, 2001) provides guidance on the performance of five-year reviews. It is anticipated that this alternative would remove all soil with TMP concentrations above PRGs. However, TMPs may remain in soil at concentrations that may not allow for unlimited use and unrestricted exposure. Therefore, five-year reviews will be conducted as required under CERCLA. For cost estimating purposes, this alternative assumes five-year reviews to be conducted for 30 years.

4.2.4.1 TMP 5 Overall Protection of Human Health and the Environment

This alternative would be protective of human health and the environment by physically removing soil with TMP concentrations above PRGs in the vicinity of Plant B and EA-7, EA-3, and the Lake Poly Area (EA-1), thereby reducing potential risk and eliminating the exposure pathway to public health by removing the volatile contaminants from the soil/groundwater smear zone. Physically removing TMP impacted soil in these three areas of the Site would also mitigate potential indoor air vapor intrusion into future buildings that may be constructed in these areas of the Site. Therefore, this alternative would achieve the RAO of mitigating potential impacts to public health resulting from subsurface-to-indoor air vapor intrusion into buildings at the Site.

4.2.4.2 TMP 5 Compliance with ARARs

The location-, chemical-, and action-specific ARARs that are applicable to the TMP alternatives are identified in **Tables 2.1-1 through 2.1-3**. The applicability of the individual ARARs with respect to each alternative, and how the alternative will comply with the ARARs is identified in the tables.

Potential, but unlikely, location-specific ARARs related to TMPs in soil include encountering endangered species, migratory birds, areas of critical environmental concern, and historical and/or archeological resources, as identified in **Table 2.1-1**. If any of these location-specific ARARs are identified, design and implementation of the remedy with comply with applicable federal and state regulations.

No applicable or relevant and appropriate chemical-specific requirements have been identified for this alternative. However, site-specific PRGs have been developed to comply with the "to be considered" criteria or guidance identified in the chemical-Specific ARARs presented in **Table 2.1-2**, including but not limited to USEPA risk assessment guidance documents and Regional Screening Levels.

This alternative would be designed and implemented to comply with the action-specific ARARs identified in **Table 2.1-3**, including but not limited to, federal and state air emission standards and RCRA Subtitle C regulations related to soil characterization, waste identification, waste handling, storage, treatment, and disposal requirements.

Excavation dewatering fluids would be treated with GAC followed by discharge to surface water. This discharge would need to meet the substantive discharge standards of the NPDES and the Massachusetts Surface Water Discharge Permit Program.

This alternative involves excavation and off-site disposal of areas of elevated TMP concentrations in subsurface soil. The TMP-impacted soil is not a listed hazardous waste. However, excavated soil would be analyzed to determine whether the material may be classified as a characteristic hazardous waste. Any hazardous waste generated during the remedial action would be handled, stored, tracked, and disposed of in accordance with the various requirements of RCRA Subtitle C and Massachusetts Hazardous Waste Rules, both of which have been identified as action-specific requirements for this alternative.

4.2.4.3 TMP 5 Long-term Effectiveness and Permanence

This alternative would provide long-term effectiveness by permanently removing TMPs at concentrations above PRGs from the soil/groundwater smear zone. Post-remediation sampling would be conducted to verify achievement of PRGs and long-term protection of human health and the environment.

Removing TMP impacted soil would mitigate potential indoor air vapor intrusion into future buildings that may be constructed in these areas of the Site, thereby providing additional long-term effectiveness and permanence.

Completion of the on-site activities from pre-design investigations through final verification sampling and reporting, are estimated to take approximately one year. Additionally, five-year reviews would be conducted as required under CERCLA. For cost estimating purposes, this alternative assumes five-year reviews would be conducted for 30 years.

This alternative involves physical removal of TMPs associated with the soil/groundwater smear zone, which contains the highest concentrations of TMPs. The goal of the alternative is to remove soil with TMP concentrations above the established PRGs, thereby resulting in minimal contamination remaining and minimal risk to receptors following completion of this alternative.

4.2.4.4 TMP 5 Reduction of Toxicity, Mobility, or Volume through Treatment

This alternative would involve physical removal of subsurface soil with TMP concentrations above PRGs in the vicinity of Plant B and EA-7, EA-3, and the Lake Poly Area (EA-1). Physical removal of these soils would reduce the toxicity, mobility, and volume of TMPs in subsurface soil in these areas of the Site.

Approximately 5,648 cy of excavated soil would be treated on-site by adding a stabilizing agent such as Portland cement, prior to being transported off-site for disposal. The volume of soil anticipated to be treated on-site (5,648 cy) is approximately 40% of the total estimated volume of soil to be excavated as part of this alternative (13,555 cy).

Based on available Site data, an estimated 6,200 pounds (approximately 3 tons) of TMPs will be excavated as part of the estimated 5,648 cy (approximately 10,000 tons) of smear zone soil proposed to be removed from the subsurface in the vicinity of Plant B and EA-7, EA-3, and the Lake Poly Area (EA-1).

This alternative would involve excavation of soil below the water table, which would likely require dewatering of the excavation to facilitate removal of TMP impacted subsurface soil in relatively dry conditions. Excavation dewatering fluids would be treated on-site using a portable (e.g., skid-mounted) treatment unit consisting of GAC. The treated water would then be discharged to a surface water body, likely to East Ditch for the Plant B/EA-7 and EA-3 areas and the off-PWD for the Lake Poly Area (EA-1).

This alternative involves on-site stabilization to treat the excavated soil prior to off-site disposal (i.e., the contaminants are chemically immobilized by processes that reduce the leachability of the contaminants, and the immobilization of contaminants is irreversible). Therefore, this alternative satisfies the statutory preference for treatment as a principal element.

4.2.4.5 TMP 5 Short-term Effectiveness

This alternative would involve excavation, treatment, and off-site disposal, which would be effective at removing TMPs from subsurface soil in the vicinity of Plant B and EA-7, EA-3, and the Lake Poly Area (EA-1). This alternative would be protective of human health and the environment and would provide short-term effectiveness upon completion of construction-related activities associated with this alternative, which is estimated to be approximately one year. Potential short-term risks to on-site workers involved in the remedial activities would be minimized by conducting the work in accordance with a site-specific HASP. Potential short-term risks to the community would be addressed by minimizing dust, implementing an air monitoring program, decontaminating vehicles transporting excavated soil prior to leaving the Site, and minimizing vehicular traffic associated with the remediation effort from traveling through residential areas.

TMPs are highly volatile and therefore an appropriate air monitoring program would be implemented to assess emissions associated with the excavation and soil handling activities and alert operators to make adjustments if emissions may impact nearby receptors.

4.2.4.6 TMP 5 Implementability

The major components of this alternative are excavation, on-site treatment (soil stabilization), and off-site disposal. The technologies used for this alternative are generally implementable, readily available, and sufficiently demonstrated for use at the Site. The alternative would use standard construction equipment, and the equipment, materials, and disposal facility are readily available.

Pre-design investigation activities would include verification of the locations of subsurface utilities that may be present within the proposed excavation areas. Some subsurface utilities may require relocation and/or protection (e.g., shoring to support subsurface piping) during excavation activities.

The proposed excavation area associated with EA-3, located east of Plant B, is within the railroad right-of-way and adjacent to East Ditch. Due to these constraints, excavation of this area may be difficult implement. Sheet piling may be necessary in order to access and excavate TMP impacted soil within the railroad right-of-way and adjacent to East Ditch. These potential concerns would be addressed during remedial design.

Due to the high volatility of TMPs and the close proximity to receptors and/or the general public, work associated with the smear zone soils is assumed to be conducted in an enclosed structure with negative air pressure and air treatment. Additionally, work may need to be conducted in Level C or Level B PPE, which would be determined based on a site-specific HASP to be prepared for this project.

TMPs are highly volatile and therefore an air monitoring program would be implemented to assess emissions associated with the excavation and soil handling activities and alert operators to make adjustments if emissions may impact nearby receptors.

TMPs occur mostly within the “smear zone” coincident with the annual high and low water table conditions. Therefore, removal of these soils may require excavation dewatering to facilitate soil removal in relatively dry conditions. Excavation dewatering would likely involve treating this water on-site using a portable (e.g., skid-mounted) treatment unit consisting of GAC. The treated water would then be discharged to a surface water body, likely to East Ditch for the Plant B/EA-7 and EA-3 areas and the off-PWD for the Lake Poly Area (EA-1). These technologies are also readily implementable and are well proven techniques for excavation dewatering.

4.2.4.7 TMP 5 Cost

The cost estimate for this alternative is presented in **Table 4.2-4** and includes the following major components:

- Institutional controls
- Pre-design investigations
- Excavation of TMP-impacted soil at Plant B and EA-7, EA-3, and Lake Poly Area (EA-1)
- Excavation dewatering, as necessary
- Dewatering/stabilization of excavated soil, as necessary
- Off-site disposal of excavated soil
- Verification sampling
- Backfill and restoration
- Reporting
- Five-year Site review

The estimated time to complete the on-site remedial activities associated with this alternative is approximately four months, and the overall duration of this remedy (including predesign, design, verification and reporting) is estimated to be approximately one year.

This alternative includes post-remediation verification sampling to confirm achievement of RAOs and PRGs for TMPs. It is anticipated that this alternative would remove all soil with TMP concentrations above PRGs. However, TMPs may remain in soil at concentrations that may not allow for unlimited use and unrestricted exposure. Therefore, five-year reviews will be conducted as required under CERCLA. For cost estimating purposes, this alternative assumes five-year reviews to be conducted for 30 years.

Costs for excavation, dewatering, stabilization, off-site disposal, backfill, and restoration were provided by environmental remediation contractors. Costs associated with pre-design investigations, verification sampling, and reporting are based on costs for similar projects.

The cost estimate for this alternative, presented in **Table 4.2-4**, is summarized as follows:

Alternative TMP 5: Excavation and Off-Site Disposal	
Capital Cost	$4,198,000
O&M Cost	$30,000
Total Cost	$4,228,000
Net Present Worth	$4,209,000
Overall Alternative Duration	30 years

4.3 Upland Soil

This section presents the detailed analysis for the following remedial alternatives for upland soil:

Alternative Soil 2: Cover Systems
Alternative Soil 3: Excavation (0-1 ft) and Cover Systems
Alternative Soil 4: Excavation (0-10 ft) and Off-Site Disposal

4.3.1 Alternative Soil 2: Cover Systems

This alternative involves placement of a cover system over areas of upland soil with elevated concentrations of chromium and/or BEHP. The purpose of the cover is to prevent ecological receptor exposure to soil with chromium and/or BEHP at concentrations above the upland soil PRGs of 1,000 mg/kg for chromium and 3 mg/kg for BEHP. For cost estimating purposes, the cover would consist of either a 1-foot soil layer or a 3-inch layer of asphalt pavement. Areas that are already inaccessible because they are under buildings or are covered with competent concrete or asphalt would be maintained without additional cover.

The available analytical data for chromium and BEHP in upland soils, exclusive of the Containment Area, with a comparison to the PRGs, is shown on **Figures 2.2-1 and 2.2-2** for upland soils from 0-1 foot and 1-10 feet, respectively. Note, the Containment Area is addressed in the IAFS, which is a companion document to this OU1/OU2 FS. For cost estimating purposes, the estimated areas of remediation for this alternative are shown on **Figure 4.3-1** based on available data**,** which coincides with soil impacts from 0-1 foot. However, the actual limits of remediation will be based on additional data obtained during pre-design investigations, as described later in this section.

Components of Alternative Soil 2

The scope of this alternative includes the following major components:

- Institutional controls
- Pre-design investigations
- Design
- Placement of a soil cover or asphalt cover over areas of shallow (0-1′) chromium- and/or BEHP-impacted upland soil where no cover currently exists
- Development of a Soil Management Plan
- Long-term maintenance
- Reporting
- Five-year Site reviews

Overall Estimated Duration for the Alternative

The overall project duration is estimated to take approximately 19 months summarized as follows:

• Pre-design work plan, sampling and analyses	8 months
• Design	2 month
• Contracting and On-site remedial activities	4 months
• Soil Management Plan	3 months
• Reporting	2 months

In addition, five-year Site reviews would be conducted as required under CERCLA. For cost estimating purposes, this alternative assumes long-term maintenance and five-year Site reviews would be conducted for 30 years.

Institutional controls

ICs would be implemented through measures that may include, but not limited to, a local town ordinance, a NAUL, or a GERE.

Institutional controls would likely include a Soil Management Plan that would ensure covers over upland soil in these remediation areas and provide strict requirements to minimize future excavation of soil in these remediation areas. In the event that future excavation is necessary, the Soil Management Plan would provide requirements to prohibit subsurface soil with COC concentrations above PRGs from being placed at the ground surface and would specify appropriate waste management practices, USEPA involvement, etc.

Pre-design investigations and design

Pre-design investigations would consist of direct-push drilling and/or hand borings to confirm the limits of chromium and BEHP in the upper foot of soil. For cost estimating purposes, the field effort for this investigation is anticipated to be completed in three days. The pre-design investigation data would be evaluated to determine the actual extent of areas that would require remediation.

A remedial design would be prepared to provide detailed drawings and specifications for how and where the soil and asphalt covers would be installed.

Covering of chromium- and BEHP-impacted soil

This alternative assumes the areas shown on **Figure 2.2-2** for upland soils 0-1 foot would be covered. The oblong area east of the Containment Area, the two areas in the vicinity of former Lake Poly, the small isolated area just outside the northwest portion of the Containment Area, and a small area to the east of Plant B would be covered with a 1-foot soil layer, an estimated 28,000 square feet. The remaining areas in the northern portion of the OCSS, an estimated 38,500 square feet, are currently covered with asphalt. For cost estimating purposes, it has been assumed that 75% of the asphalt in this area is not competent and would be covered with a 3-inch asphalt pavement layer.

In areas where the top foot of soil already meets the PRGs, no additional physical remediation activities would be necessary for chromium and/or BEHP exceedances of the PRGs in deeper soils. The existing soil and/or asphalt provides the soil cover over the subsurface soil contamination and the institutional controls prevent future exposure.

For purposes of costing and overall alternative evaluation, the areas assumed to be covered as part of this alternative are shown on **Figure 4.3-1**.

Long-term maintenance

Periodic inspections would be conducted in the areas that are covered as part of this alternative to verify that the integrity of the covers have not been compromised. If soil erosion is identified in the areas covered with soil, the eroded soil areas would be repaired to achieve and maintain post-remediation conditions. Deteriorated and/or damaged areas of asphalt pavement covers would be repaired to achieve and maintain post-remediation conditions.

For cost estimating purposes, a one-day inspection event is included on an annual basis, and minor repair costs are included every five years to coincide with the five-year reviews. These repairs are assumed to include minor repairs to eroded soil areas and patching, resealing and/or replacement of damaged asphalt areas.

Reporting

A Remedial Action Report would be prepared to document the remedial action, including a figure that shows the actual extent of areas covered with soil and asphalt layers.

Five-year Site reviews

- CERCLA requires that any remedial action that results in contaminants remaining on-site at concentrations above those allowing for unlimited exposure and unrestricted use must be reviewed at least every five years. During five-year site reviews, an assessment is made as to whether the implemented remedy continues to be protective of human health and the environment, or whether the implementation of additional remedial action is appropriate. The USEPA document Comprehensive Five-Year Review Guidance (USEPA, 2001) provides guidance on the performance of five-year reviews. It is anticipated that this alternative would cover all areas of upland soil with chromium and BEHP concentrations above PRGs, thereby preventing ecological receptor exposure to these impacted soils. However, chromium and/or BEHP will remain in soil deeper than one foot that will exceed PRGs and therefore will not allow for unlimited use and unrestricted exposure (i.e., use as a residential property, school, or daycare facility). Therefore, five-year reviews will be conducted as required under CERCLA. For cost estimating purposes, this alternative assumes five-year reviews to be conducted for 30 years.

4.3.1.1 Alternative Soil 2 Overall Protection of Human Health and the Environment

This alternative would be protective of human health and the environment by providing a cover over impacted soils thereby reducing potential risk and eliminating the exposure pathway to potential human and ecological receptors. Institutional controls would prevent exposure to deeper soils. Therefore, this alternative would achieve the RAO of preventing exposure by current and future ecological receptors.

4.3.1.2 Alternative Soil 2 Compliance with ARARs

The location-, chemical-, and action-specific ARARs that are applicable to the chromium and BEHP in soil alternatives are identified in **Tables 2.1-4 through 2.1-6**. The applicability of the individual ARARs with respect to each alternative, and how the alternative will comply with the ARARs is identified in the tables.

Potential, but unlikely, location-specific ARARs related to the chromium and BEHP in soil alternatives include encountering endangered species, migratory birds, areas of critical environmental concern, and historical and/or archeological resources, as identified in **Table 2.1-4**. If any of these location-specific ARARs are identified, design and implementation of the remedy with comply with applicable federal and state regulations.

No applicable or relevant and appropriate chemical-specific requirements have been identified for this alternative. However, site-specific PRGs have been developed to comply with the "to be considered" criteria or guidance identified in the chemical-Specific ARARs presented in **Table 2.1-5**, including but not limited to USEPA risk assessment guidance documents.

This alternative would be designed and implemented to comply with the action-specific ARARs identified in **Table 2.1-6**, including but not limited to, RCRA Subtitle C regulations related to soil characterization, waste identification, waste handling, storage, treatment, and disposal requirements.

This alternative involves covering of areas of elevated chromium and/or BEHP concentrations in upland soil. However, if any soil is excavated, it would be analyzed to determine whether the material may be classified as a characteristic hazardous waste. Any hazardous waste generated during the remedial action would be handled, stored, tracked, and disposed of in accordance with the various requirements of RCRA Subtitle C and Massachusetts Hazardous Waste Rules. Both of which have been identified as applicable action-specific requirements for this alternative. This alternative would not likely result in the occupancy and modification of floodplains. A portion of the upland soils are located within the 500-year floodplain according to the FEMA National Flood Layer map, but this area is directly adjacent to the Containment Area, which is at an elevation above the 500-year floodplain. A stormwater study will be undertaken as part of the pre-design investigations to confirm that this is the case and that occupancy of the 500-year floodplain will not occur. If temporary impacts to the floodplain are found to be unavoidable while implementing the cleanup actions, appropriate measures will be incorporated into the cleanup design and subsequently implemented during the Remedial Action phase to ensure that current flood storage capacities (and flood stages or velocities) and any adjacent wetlands are not affected during and after completion of the proposed remedial actions. BMPs will be used during the construction phase, which include erosion control measures, proper regrading, and restoration and monitoring of impacted areas.

4.3.1.3 Alternative Soil 2 Long-term Effectiveness and Permanence

This alternative would provide long-term effectiveness and permanence by providing a cover over impacted upland soil that exceeds ecological PRGs. The cover would prevent exposure by current and future ecological receptors to surface and subsurface soil containing chromium and/or BEHP that would result in potential adverse impacts.

Completion of the on-site activities from pre-design investigations through remedial action and reporting, are estimated to take approximately 19 months. Additionally, five-year reviews would be conducted as required under CERCLA. For cost estimating purposes, this alternative assumes five-year reviews would be conducted for 30 years.

4.3.1.4 Alternative Soil 2 Reduction of Toxicity, Mobility, or Volume through Treatment

This alternative would reduce the mobility of the site-related COCs by providing a cover over impacted areas. This alternative does not include any active measures to reduce the toxicity or volume of contaminants. Additionally, this alternative does not include any treatment technologies and therefore, does not satisfy the statutory preference for treatment as a principal element.

4.3.1.5 Alternative Soil 2 Short-term Effectiveness

This alternative would provide short-term effectiveness upon completion of construction-related activities, by preventing exposure of ecological receptors with a one-foot cover over impacted material. Potential short-term risks to on-site workers involved in the remedial activities would be minimized by conducting the work in accordance with a site-specific HASP. Potential short-term risks to the community would be addressed by minimizing dust and minimizing vehicular traffic associated with the remediation effort from traveling through residential areas.

4.3.1.6 Alternative Soil 2 Implementability

The major component of this alternative is covering of upland soils with chromium and/or BEHP concentrations that would result in potential adverse impacts to ecological receptors. The technologies used for this alternative are generally implementable, readily available, and sufficiently demonstrated for use at the Site. This alternative would use standard construction equipment, and the equipment and materials are readily available.

4.3.1.7 Alternative Soil 2 Cost

The cost estimate for this alternative is presented in **Table 4.3-1** and includes the following major components:

- Institutional controls
- Pre-design investigations
- Design
- Placement of a soil or asphalt cover over areas of chromium- and/or BEHP-impacted upland soil
- Remedial Action Reporting
- Soil Management and Site Maintenance Plan
- Annual inspections and long-term maintenance
- Five-year Site reviews

The estimated time to complete the on-site remedial activities associated with this alternative is approximately 4 months, and the overall duration of this remedy (including pre-design, design, covering and reporting) is estimated to be approximately 19 months.

It is anticipated that this alternative would provide a 1-foot cover for all soil with chromium and BEHP concentrations above PRGs. However, chromium and/or BEHP will remain in soil deeper than 1 foot at concentrations that will not allow for unlimited use and unrestricted exposure. Therefore, five-year reviews will be conducted as required under CERCLA. For cost estimating purposes, this alternative assumes five-year reviews to be conducted for 30 years.

Costs for on-site remedial activities were provided by environmental remediation contractors. Costs associated with pre-design investigations, design, and reporting are based on costs for similar projects. Net present worth cost was calculated based on a 7% annual discount rate.

The cost estimate for this alternative, presented in **Table 4.3-1**, is summarized as follows:

Alternative Soil 2: Cover Systems	
Capital Cost	$490,000
O&M Cost	$90,000
Total Cost	$580,000
Net Present Worth	$522,000
Overall Alternative Duration	30 years

4.3.2 Alternative Soil 3: Excavation (0-1 ft) and Cover Systems

This alternative involves a combination of limited excavation and covering of areas of upland soil with elevated concentrations of chromium and/or BEHP. The purpose of the combined limited excavation and covering system is to prevent ecological receptor exposure to soil with chromium and/or BEHP at concentrations above the upland soil PRGs of 1,000 mg/kg for chromium and 3 mg/kg for BEHP. For cost estimating purposes, impacted soil from 0-1 foot would first be excavated, and the area backfilled to cover deeper soils (>1 foot) with either a 1-foot soil layer or a 9-inch soil layer and 3-inch layer of asphalt pavement.

The available analytical data for chromium and BEHP in upland soils, exclusive of the Containment Area, with a comparison to the PRGs, are shown on **Figures 2.2-2 and 2.2-3** for upland soils from 0-1 foot and 1-10 feet, respectively. Note, the Containment Area is addressed in the IAFS, which is a companion document to this OU1/OU2 FS. For cost estimating purposes, the estimated areas of remediation for this alternative of upland soils, based on available data, are specified on **Figure 4.3-1,** which coincides with soil impacts from 0-1 foot. However, the actual limits of remediation will be based on additional data obtained during pre-design investigations, as described later in this section.

No additional physical remediation activities would be necessary for areas of chromium and/or BEHP in upland soil from 1-10 feet because the soil COC concentrations in these areas from 0-1 foot are already below the upland soil PRGs and/or are assumed to be below the PRGs based on the proposed pre-design investigation results. Therefore, this existing soil provides the 0-1 foot soil cover over the subsurface soil contamination.

Components of Alternative Soil 3

The scope of this alternative includes the following major components:

- Institutional controls
- Pre-design investigations
- Design
- Excavation of chromium- and BEHP-impacted soils from the 0-1 foot bgs interval at select locations
- Off-site disposal of excavated soil
- Backfill, Cover and Restoration
- Development of a Soil Management Plan
- Long-term maintenance
- Reporting
- Five-year Site reviews

Overall Estimated Duration for the Alternative

The overall project duration is estimated to take approximately 22 months, summarized as follows:

- Pre-design work plan, sampling and analyses 8 months
- Design 3 months
- Contracting and On-site remedial activities 5 months
- Soil Management Plan 3 months
- Reporting 3 months

In addition, five-year Site reviews would be conducted as required under CERCLA. For cost estimating purposes, this alternative assumes long-term maintenance and five-year Site reviews would be conducted for 30 years.

Institutional controls

ICs would be implemented through measures that may include, but not limited to, a local town ordinance, a NAUL, or a GERE.

Institutional controls would likely include a Soil Management Plan that would ensure covers over upland soil in these remediation areas and provide strict requirements to minimize future excavation of soil in these remediation areas. In the event that future excavation is necessary, the Soil Management Plan would provide requirements to prohibit subsurface soil with COC concentrations above PRGs from being placed at the ground surface and would specify appropriate waste management practices, USEPA involvement, etc.

Pre-design investigations and design

Pre-design investigations would consist of direct-push drilling and/or hand borings to confirm the limits of chromium and BEHP in the upper foot of soil. For cost estimating purposes, the field effort for this investigation is anticipated to be completed in three days. The pre-design investigation data would be evaluated to determine the actual extent of areas that would require remediation.

A remedial design would be prepared to provide detailed drawings and specifications for how and where the areas of soil excavation and covering would be conducted.

Limited Excavation

Upland soil areas where excavation from 0-1 foot is assumed are outlined as shown on **Figure 4.3-1.** These areas are assumed to be excavated to a depth of 1 foot bgs. The areas specified for excavation on **Figure 4.3-1** represent a total of approximately 65,000 square feet. Assuming an excavation depth of 1 foot, the estimated volume of chromium- and BEHP-impacted upland soil is approximately 2,400 cubic yards.

Given that the excavated soil is surficial, it is not anticipated to require stabilization or dewatering.

Off-site disposal of excavated soil

The influent to Plant B contains BEHP, which is a listed RCRA hazardous waste (U028: diethylhexyl phthalate). For cost estimating purposes this alternative assumes that approximately 10% of the excavated soil (approximately 240 cubic yards or 385 tons) would be considered a listed hazardous waste due to the excavated soil containing BEHP and its proximity to Plant B.

Remaining excavated soil (approximately 2,160 cubic yards) would be shipped off-site for disposal as non-hazardous waste. For estimating purposes this would result in approximately 385 tons of listed hazardous waste and 3,460 tons on non-hazardous waste.

Backfill, Cover and Restoration

This alternative assumes the excavated areas would be backfilled with soil of appropriate quality. For cost estimating purposes, it is assumed that the surface layer of the excavation areas would consist of material similar to that of pre-excavation conditions. For example, excavation areas that exhibited concrete or asphalt at the ground surface would be re-paved with asphalt. Excavation areas where soil was present at the ground surface would be backfilled with soil to the ground surface. Of the estimated 65,000 square foot excavation area, approximately 28,000 square feet would be covered with soil and approximately 38,500 square feet would be covered with soil and an asphalt layer.

This alternative assumes the areas shown on **Figure 4.3-1** for upland soils 0-1 foot would be excavated and backfilled with soil of appropriate quality. In areas where the top foot of soil already meets the PRGs, no additional physical remediation activities would be necessary for chromium and/or BEHP exceedances of PRGs in deeper soil. The existing soil (and asphalt in some cases) provides the soil cover over the subsurface soil contamination, and the institutional controls would prevent future exposure.

Long-term maintenance

Periodic inspections would be conducted of the areas that were excavated and covered as part of this alternative to verify that the integrity of the covers have not been compromised. If soil erosion is identified in the areas covered with a soil, the eroded soil areas would be repaired to achieve and maintain post-remediation conditions. Deteriorated and/or damaged areas of asphalt pavement cover that are identified would be repaired to achieve and maintain post-remediation conditions.

For cost estimating purposes, a one-day inspection event is included on an annual basis, and minor repair costs are included every five years to coincide with the five-year reviews. These repairs are assumed to include minor repairs to eroded soil areas and minor patching/replacement of damaged asphalt areas.

Reporting

A Remedial Action Report would be prepared to document the remedial action, including a figure that shows the actual extent of areas excavated and covered with soil and asphalt layers, along with documentation of off-site soil disposal.

Five-year site reviews

CERCLA requires that any remedial action that results in contaminants remaining on-site at concentrations above those allowing for unlimited exposure and unrestricted use must be reviewed at least every five years. During five-year site reviews, an assessment is made as to whether the implemented remedy continues to be protective of human health and the environment, or whether the implementation of additional remedial action is appropriate. The USEPA document Comprehensive Five-Year Review Guidance (USEPA, 2001) provides guidance on the performance of five-year reviews. It is anticipated that this alternative would excavate all areas of upland soil with chromium and BEHP concentrations above PRGs in the upper foot and replace with clean cover material, thereby preventing ecological receptor exposure to these impacted soils. However, chromium and/or BEHP will remain in soil deeper than one foot that will exceed PRGs and therefore will not allow for unlimited use and unrestricted exposure (i.e., use as a residential property, school, or daycare facility). Therefore, five-year reviews will be conducted as required under CERCLA. For cost estimating purposes, this alternative assumes five-year reviews to be conducted for 30 years.

4.3.2.1 Alternative Soil 3 Overall Protection of Human Health and the Environment

This alternative would be protective of human health and the environment by providing a cover over impacted soils thereby reducing potential risk and eliminating the exposure pathway to potential human and ecological receptors. Institutional controls would prevent exposure to deeper soils. Therefore, this alternative would achieve the RAO of preventing exposure by current and future ecological receptors.

4.3.2.2 Alternative Soil 3 Compliance with ARARs

The location-, chemical-, and action-specific ARARs that are applicable to the chromium and BEHP in soil alternatives are identified in **Tables 2.1-4 through 2.1-6**. The applicability of the individual ARARs with respect to each alternative, and how the alternative will comply with the ARARs is identified in the tables.

Potential, but unlikely, location-specific ARARs related to the chromium and BEHP in soil alternatives include encountering endangered species, migratory birds, areas of critical environmental concern, and historical and/or archeological resources, as identified in **Table 2.1-4**. If any of these location-specific ARARs are identified, design and implementation of the remedy with comply with applicable federal and state regulations.

No applicable or relevant and appropriate chemical-specific requirements have been identified for this alternative. However, site-specific PRGs have been developed to comply with the "to be considered" criteria or guidance identified in the chemical-Specific ARARs presented in **Table 2.1-5**, including but not limited to USEPA risk assessment guidance documents.

This alternative would be designed and implemented to comply with the action-specific ARARs identified in **Table 2.1-6**, including but not limited to, RCRA Subtitle C regulations related to soil characterization, waste identification, waste handling, storage, treatment, and disposal requirements.

This alternative involves excavation and off-site disposal of areas of upland soil from 0 to 1 foot bgs with elevated chromium and/or BEHP concentrations. The influent to Plant B contains BEHP, which is a listed RCRA hazardous waste (U028: diethylhexyl phthalate). Therefore, for cost estimating purposes, this alternative assumes that approximately 10% of the excavated soil (approximately 240 cy) would be considered a listed hazardous waste due to containing BEHP. The remaining excavated soil (approximately 2,160 cy) is assumed to be characterized as non-hazardous waste. However, the excavated soil would be analyzed to determine whether the material may be classified as a characteristic hazardous waste. Any hazardous waste generated during the remedial action would be handled, stored, tracked, and disposed of in accordance with the various requirements of RCRA Subtitle C and Massachusetts Hazardous Waste Rules. Both of which have been identified as applicable action-specific requirements for this alternative. This alternative would not likely result in the occupancy and modification of floodplains. A portion of the upland soils are located within the 500-year floodplain according to the FEMA National Flood Layer map, but this area is directly adjacent to the Containment Area, which is at an elevation above the 500-year floodplain. A stormwater study will be undertaken as part of the pre-design investigations to confirm that this is the case and that occupancy of the 500-year floodplain will not occur. If temporary impacts to the floodplain are found to be unavoidable while implementing the cleanup actions, appropriate measures will be incorporated into the cleanup design and subsequently implemented during the Remedial Action phase to ensure that current flood storage capacities (and flood stages or velocities) and any adjacent wetlands are not affected during and after completion of the proposed remedial actions. BMPs will be used during the construction phase, which include erosion control measures, proper regrading, and restoration and monitoring of impacted areas.

4.3.2.3 Alternative Soil 3 Long-term Effectiveness and Permanence

This alternative would provide long-term effectiveness and permanence by replacing surficial impacted soil with cover material over remaining deeper impacted upland soil that exceeds ecological PRGs. The cover would prevent exposure by current and future ecological receptors to surface and subsurface soil containing chromium and/or BEHP that would result in potential adverse impacts.

Completion of the on-site activities from pre-design investigations through remedial action and reporting, are estimated to take approximately 22 months. Additionally, five-year reviews would be conducted as required under CERCLA. For cost estimating purposes, this alternative assumes five-year reviews would be conducted for 30 years.

4.3.2.4 Alternative Soil 3 Reduction of Toxicity, Mobility, or Volume through Treatment

This alternative would reduce contaminant toxicity and volume by physical removal of impacted upland soil from 0 to 1 foot bgs. This alternative would also reduce the mobility of the site-related COCs by providing a cover over the impacted areas. However, this alternative does not include any treatment technologies and therefore, does not satisfy the statutory preference for treatment as a principal element.

4.3.2.5 Alternative Soil 3 Short-term Effectiveness

This alternative would provide short-term effectiveness upon completion of construction-related activities, by preventing exposure of ecological receptors with a one-foot cover over impacted material. Potential short-term risks to on-site workers involved in the remedial activities would be minimized by conducting the work in accordance with a site-specific HASP. Potential short-term risks to the community would be addressed by minimizing dust and minimizing vehicular traffic associated with the remediation effort from traveling through residential areas.

4.3.2.6 Alternative Soil 3 Implementability

The major components of this alternative are excavation, off-site disposal, and covering. The technologies used for this alternative are generally implementable, readily available, and sufficiently demonstrated for use at the Site. This alternative would use standard construction equipment, and the equipment, materials, and disposal facility are readily available.

4.3.2.7 Alternative Soil 3 Cost

The cost estimate for this alternative is presented in **Table 4.3-2** and includes the following major components:

- Institutional controls
- Pre-design investigations
- Design
- Excavation of chromium- and BEHP-impacted soils from the 0-1 foot bgs interval at select locations
- Off-site disposal of excavated soil
- Backfill, cover and restoration
- Reporting
- Soil Management and Site Maintenance Plan
- Annual inspections and long-term maintenance
- Five-year Site reviews

The estimated time to complete the on-site remedial activities associated with this alternative is approximately 5 months, and the overall duration of this remedy (including pre-design, design, verification, and reporting) is estimated to be approximately 22 months.

It is anticipated that this alternative would remove upland soil from 0 to 1 foot bgs with chromium and BEHP concentrations above PRGs. However, chromium and/or BEHP will remain in soil deeper than 1 foot at concentrations that will not allow for unlimited use and unrestricted exposure. Therefore, five -year reviews will be conducted as required under CERCLA. For cost estimating purposes, this alternative assumes five-year reviews to be conducted for 30 years.

Costs for excavation, off-site disposal, backfill, covering, and restoration were provided by environmental remediation contractors. Costs associated with pre-design investigations, design, verification sampling, and reporting are based on costs for similar projects. Net present worth cost was calculated based on a 7% annual discount rate.

The cost estimate for this alternative, presented in **Table 4.3-2**, is summarized as follows:

Alternative Soil 3: Excavation (0-1 ft) and Cover Systems	
Capital Cost	$1,247,000
O&M Cost	$90,000
Total Cost	$1,337,000
Net Present Worth	$1,279,000
Overall Alternative Duration	30 years

4.3.3 Alternative Soil 4: Excavation (0-10 ft) and Off-Site Disposal

This alternative involves excavation and off-site disposal of areas of upland soil with elevated concentrations of chromium and/or BEHP above the upland soil PRGs of 1,000 mg/kg for chromium and 3 mg/kg for BEHP. The available analytical data for chromium and BEHP in upland soils, exclusive of the Containment Area, with a comparison to the PRGs, is shown on **Figures 2.2-2 and 2.2-3** for upland soils from 0-1 foot and 1-10 feet, respectively. Note, the Containment Area is addressed in the IAFS, which is a companion document to this OU1/OU2 FS. For cost estimating purposes, the estimated areas of remediation for upland soils, based on available data, are shown also on **Figures 2.2-2 and 2.2-3**. However, the actual limits of remediation will be based on additional data obtained during pre-design investigations, as described later in this section.

The purpose of this alternative is to prevent ecological receptor expose to soil with chromium and/or BEHP at concentrations above the PRGs. Based on available upland soil analytical data, the majority of PRG exceedances for chromium and BEHP in upland soils is generally limited to approximately 8 feet bgs. Therefore, for cost estimating purposes, this alternative assumes that the remediation areas outlined as shown on **Figure 4.3-2,** which combines the footprints of **Figures 2.2-2 and 2.2-3** would be excavated to an average depth of 8 feet bgs. The actual excavation depths would be determined during remedial design and would be based on additional pre-design investigation data to be collected.

Excavated soil would be shipped off-site for disposal and the excavations would be backfilled with soil of appropriate quality. The surface material of the completed excavations would generally match pre-excavation conditions.

Components of Alternative Soil 4

The scope of this alternative includes the following major components:

- Institutional controls
- Pre-design investigations
- Design
- Excavation of chromium- and/or BEHP-impacted upland soil
- Stabilization of excavated soil, as necessary
- Off-site disposal of excavated soil
- Verification sampling
- Backfill and restoration
- Reporting
- Five-year Site reviews

Overall Estimated Duration for the Alternative

The overall project duration is estimated to take approximately 2 years, summarized as follows:

- Pre-design work plan, sampling and analysis — 10 months
- Design — 4 months
- On-site remedial activities — 6 months
- Verification sampling and Reporting — 4 months

In addition, five-year Site reviews would be conducted as required under CERCLA. For cost estimating purposes, this alternative assumes that five-year Site reviews would be conducted for 30 years.

Institutional controls

ICs would be implemented through measures that may include, but not limited to, a local town ordinance, a NAUL, or a GERE.

Pre-design investigations and design

Pre-design investigations would consist of a direct-push drilling program to confirm the limits of chromium and BEHP in soil that require remediation. For cost estimating purposes, the field effort for this investigation is anticipated to be completed in five days. The pre-design investigation data would be evaluated to determine the actual extent of areas that would require remediation.

A remedial design would be prepared to provide detailed drawings and specifications for how and where the areas of soil excavation would be conducted.

Excavation of chromium- and BEHP-impacted soil

The excavation limits would be based on the pre-design investigation results. For purposes of costing and overall alternative evaluation, the proposed remediation areas shown on **Figure 4.3-2** would be excavated to an average depth of approximately 8 feet bgs. For estimating purposes that equates to a total area of 117,000 square feet and approximately 35,000 cubic yards of excavated upland soil.

Three of the upland excavation areas coincide with TMPs in soils as described in Section 4.2.4. Excavation in these areas would extend to 12 feet below grade to remove TMPs and would be conducted in an enclosed structure whiling donning appropriate PPE as described in Section 4.2.4.

It is assumed that the majority of the excavations can be conducted without the use of excavation support, with the exception of the excavation at EA-3 where excavation support would be required to protect the adjacent railroad.

Dewatering/Stabilization of excavated soil

For cost estimating purpose, this alternative assumes approximately 20% of the excavated soil would require stabilization prior to off-site disposal to reduce the water content of the soil, which will also reduce leachability of the contaminants. It is anticipated that recovered water would be captured and treated through the on-site treatment system or transported off-site for disposal as a non-hazardous waste. Soil would be stabilized using Portland cement, lime, or another suitable stabilizing agent. Based on an estimated 35,000 cubic yards of excavated soil, approximately 7,000 cubic yards of excavated soil would be stabilized on-site prior to off-site disposal.

Off-site disposal of excavated soil

The influent to Plant B contains BEHP, which is a listed RCRA hazardous waste (U028: diethylhexyl phthalate). For cost estimating purposes this alternative assumes that approximately 10% of the excavated soil (approximately 3,500 cubic yards or 5,600 tons) would be considered a listed hazardous waste due to the excavated soil containing BEHP and its proximity to Plant B.

Remaining excavated soil (approximately 31,500 cy) would be shipped off-site as for disposal as non-hazardous waste. As described in the preceding paragraphs, approximately 7,000 cubic yards of excavated soil would be stabilized on-site. For estimating purposes, this volume of soil is estimated to be approximately 12,600 tons. The remaining 24,500 cubic yards of excavated soil that would not require stabilization is estimated to be approximately 39,200 tons. Therefore, approximately 57,400 tons of excavated soil would be shipped off-site for disposal: 5,600 tons of hazardous waste and 51,800 tons of non-hazardous waste.

Verification sampling

A post-remediation verification sampling program would be conducted to confirm achievement of RAOs and PRGs for chromium and BEHP in upland soils. This sampling program would include collecting soil samples at the completed excavation limits and analyzing the samples for chromium and BEHP to verify that these COC concentrations are below the established ecological PRGs.

Backfill and restoration

This alternative assumes the excavated areas would be backfilled with soil of appropriate quality. For cost estimating purposes, it is assumed that the surface layer of the excavation areas would consist of material similar to that of pre-excavation conditions. For example, excavation areas that exhibited concrete or asphalt at the ground surface would be re-paved with asphalt. Excavation areas where soil was present at the ground surface would be backfilled with soil to the ground surface. For cost estimating purposes, this alternative assumes a total excavation area of approximately 117,000 square feet, of which approximately 48,500 square feet would be in areas with soil as a cover material and approximately 68,500 square feet would be in areas where the ground surface of the backfilled excavation area with be asphalt pavement.

Reporting

A Remedial Action Report would be prepared to document the remedial action, including but not limited to the final excavation limits, on-site stabilization efforts, and waste disposal information.

Five-year site reviews

CERCLA requires that any remedial action that results in contaminants remaining on-site at concentrations above those allowing for unlimited exposure and unrestricted use must be reviewed at least every five years. During five-year site reviews, an assessment is made as to whether the implemented remedy continues to be protective of human health and the environment, or whether the implementation of additional remedial action is appropriate. The USEPA document Comprehensive Five-Year Review Guidance (USEPA, 2001) provides guidance on the performance of five-year reviews. It is anticipated that this alternative would excavate and/or cap all areas of upland soil with chromium and BEHP concentrations above PRGs, thereby preventing ecological receptor exposure to these impacted soils. However, chromium and/or BEHP may remain in soil outside the remediation areas at concentrations that may not allow for unlimited use and unrestricted exposure (i.e. use as a residential property, school, or daycare facility). Therefore, five -year reviews will be conducted as required under CERCLA. For cost estimating purposes, this alternative assumes five-year reviews to be conducted for 30 years.

4.3.3.1 Alternative Soil 4 Overall Protection of Human Health and the Environment

This alternative would be protective of human health and the environment by physically removing soil with chromium and/or BEHP concentrations above PRGs in upland soil, thereby reducing potential risk and eliminating the exposure pathway to potential human and ecological receptors.

4.3.3.2 Alternative Soil 4 Compliance with ARARs

The location-, chemical-, and action-specific ARARs that are applicable to the chromium and BEHP in soil alternatives are identified in **Tables 2.1-4 through 2.1-6**. The applicability of the individual ARARs with respect to each alternative, and how the alternative will comply with the ARARs is identified in the tables.

Potential, but unlikely, location-specific ARARs related to the chromium and BEHP in soil alternatives include encountering endangered species, migratory birds, areas of critical environmental concern, and historical and/or archeological resources, as identified in **Table 2.1-4**. If any of these location-specific ARARs are identified, design and implementation of the remedy will comply with applicable federal and state regulations.

No applicable or relevant and appropriate chemical-specific requirements have been identified for this alternative. However, site-specific PRGs have been developed to comply with the "to be considered" criteria or guidance identified in the chemical-Specific ARARs presented in **Table 2.1-5**, including but not limited to USEPA risk assessment guidance documents.

This alternative would be designed and implemented to comply with the action-specific ARARs identified in **Table 2.1-6**, including but not limited to, RCRA Subtitle C regulations related to soil characterization, waste identification, waste handling, storage, treatment, and disposal requirements.

This alternative involves excavation and off-site disposal in areas of upland soil with elevated chromium and/or BEHP concentrations. The influent to Plant B contains BEHP, which is a listed RCRA hazardous waste (U028: diethylhexyl phthalate). Therefore, for cost estimating purposes, this alternative assumes that approximately 10% of the excavated soil (approximately 3,500 cubic yards) would be considered a listed hazardous waste due to containing BEHP. This alternative also assumes that none of the excavated soil will exhibit chromium concentrations that may result in being characterized as a hazardous waste. However, the excavated soil would be analyzed to determine whether the material may be classified as a characteristic hazardous waste. Any hazardous waste generated during the remedial action would be handled, stored, tracked, and disposed of in accordance with the various requirements of RCRA Subtitle C and Massachusetts Hazardous Waste Rules, both of which have been identified as applicable action-specific requirements for this alternative. This alternative would not likely result in the occupancy and modification of floodplains. A portion of the upland soils are located within the 500-year floodplain according to the FEMA National Flood Layer map, but this area is directly adjacent to the Containment Area, which is at an elevation above the 500-year floodplain. A stormwater study will be undertaken as part of the pre-design investigations to confirm that this is the case and that occupancy of the 500-year floodplain will not occur. If temporary impacts to the floodplain are found to be unavoidable while implementing the cleanup actions, appropriate measures will be incorporated into the cleanup design and subsequently implemented during the Remedial Action phase to ensure that current flood storage capacities (and flood stages or velocities) and any adjacent wetlands are not affected during and after completion of the proposed remedial actions. BMPs will be used during the construction phase, which include erosion control measures, proper regrading, and restoration and monitoring of impacted areas.

4.3.3.3 Alternative Soil 4 Long-term Effectiveness and Permanence

This alternative would provide long-term effectiveness by permanently removing chromium and BEHP at concentrations above PRGs from upland soil areas. Removing chromium- and BEHP-impacted soil would mitigate potential future risks to ecological receptors, thereby providing long-term effectiveness and permanence.

Completion of the on-site activities from pre-design investigations through remedial activities, verification sampling, and reporting, are estimated to take approximately 2 years. Additionally, five-year reviews would be conducted as required under CERCLA. For cost estimating purposes, five-year reviews are assumed to be conducted for 30 years.

4.3.3.4 Alternative Soil 4 Reduction of Toxicity, Mobility, or Volume through Treatment

This alternative would involve physical removal of upland soil with chromium and BEHP concentrations above PRGs in areas outlined on **Figure 4.3-2**. Physical removal of these soils would reduce the toxicity, mobility, and volume of chromium and BEHP in upland soil in these areas of the Site.

Approximately 7,000 cubic yards of excavated soil would be treated on-site by adding a stabilizing agent such as Portland cement, prior to being transported off-site for disposal. The volume of soil anticipated to be treated on-site (7,000 cubic yards) is approximately 20% of the total estimated volume of soil to be excavated as part of this alternative (35,000 cubic yards).

Based on available Site data, an estimated 220,000 pounds (approximately 110 tons) of chromium and an estimated 170 pounds of BEHP are associated with the estimated 35,000 cubic yards (approximately 57,400 tons) of upland soil proposed to be excavated and disposed as part of this remedial alternative.

This alternative involves on-site stabilization to treat a portion of the excavated soil prior to off-site disposal (i.e., the contaminants are chemically immobilized by processes that reduce the leachability of the contaminants, and the immobilization of contaminants is irreversible). Therefore, this alternative satisfies the statutory preference for treatment as a principal element.

4.3.3.5 Alternative Soil 4 Short-term Effectiveness

This alternative would involve excavation, treatment, and off-site disposal, which would be effective at removing chromium and BEHP from upland soil in the areas of the Site shown on **Figure 4.3-2**. This alternative would prevent ecological receptor exposure to upland soil containing chromium and/or BEHP that would result in potential adverse impacts. Therefore, this alternative would provide short-term effectiveness upon completion of construction-related activities, which is estimated to be approximately 2 years. Potential short-term risks to on-site workers involved in the remedial activities would be minimized by conducting the work in accordance with a site-specific HASP. Potential short-term risks to the community would be addressed by minimizing dust, decontaminating vehicles transporting excavated soil prior to leaving the Site, and minimizing vehicular traffic associated with the remediation effort from traveling through residential areas.

4.3.3.6 Alternative Soil 4 Implementability

The major components of this alternative are excavation, on-site treatment as needed (soil stabilization), and off-site disposal. The technologies used for this alternative are generally implementable, readily available, and sufficiently demonstrated for use at the Site. This alternative would use standard construction equipment, and the equipment, materials, and disposal facility are readily available.

4.3.3.7 Alternative Soil 4 Cost

The cost estimate for this alternative is presented in **Table 4.3-3** and includes the following major components:

- Institutional controls
- Pre-design investigations and design
- Excavation of chromium- and/or BEHP-impacted upland soil
- Stabilization of excavated soil, as necessary
- Off-site disposal of excavated soil
- Verification sampling
- Backfill and restoration
- Reporting
- Five-year Site reviews

The estimated time to complete the on-site remedial activities associated with this alternative is approximately 6 months, and the overall duration of this remedy (including predesign, design, remedial activities, and reporting) is estimated to be approximately 2 years.

It is anticipated that this alternative would remove all soil with chromium and BEHP concentrations above PRGs. However, chromium and/or BEHP may remain in soil at concentrations that may not allow for unlimited use and unrestricted exposure (i.e. use as a residential property, school, or daycare facility). Therefore, five-year reviews will be conducted as required under CERCLA. For cost estimating purposes, this alternative assumes five-year reviews to be conducted for 30 years.

Costs for excavation, soil stabilization, off-site disposal, backfill, and restoration were provided by environmental remediation contractors. Costs associated with pre-design investigations, design, verification sampling, and reporting are based on costs for similar projects. Net present worth cost was calculated based on a 7% annual discount rate.

The cost estimate for this alternative is presented in **Table 4.3-3**, is summarized as follows:

Alternative Soil 4: Excavation and Off-Site Disposal	
Capital Cost	$13,072,000
O&M Cost	$30,000
Total Cost	$13,102,000
Net Present Worth	$13,082,000
Overall Alternative Duration	30 years

4.4 Wetland Soil and Sediment Alternatives

This section presents the detailed analysis for Alternative WSS 2: Excavation, Stabilization, and Off-Site Disposal.

4.4.1 Alternative WSS 2: Excavation and Off-Site Disposal

This alternative involves excavation and off-site disposal of areas of wetland soil and sediment with concentrations of chromium and/or BEHP above the established PRGs of 600 mg/kg (soil) and 100 mg/kg (sediment) for chromium, and 20 mg/kg (soil) and 100 mg/kg (sediment) for BEHP. This alternative includes excavation and off-site disposal of Off-Property West Ditch sediment, Upper and Lower South Ditch sediment, Central Pond sediment, and EA4 and EA5 surface soils that exceed PRGs for chromium and/or BEHP. The available analytical data for chromium and BEHP in wetland soils and sediments with a comparison to the PRGs, is shown on **Figure 4.4-1** for wetland soils and sediments 0-1 foot bgs.

The purpose of this alternative is to prevent ecological receptor exposure to soils and sediments with chromium and/or BEHP concentrations above the respective PRGs. Based on available wetland soil analytical data, the majority of PRG exceedances for chromium and/or BEHP are limited to approximately 1-foot bgs. Therefore, for cost estimating purposes, this alternative assumes that the remediation areas shown on **Figure 4.4-1,** would be excavated to a depth of 1-foot bgs. The actual excavation depths and extents would be determined during remedial design and would be based on additional wetlands delineation and data collected during a pre-design investigation.

Residual wetland soils below 1 foot that exceed PRGs will be left in place and an institutional control will be implemented to prohibit excavation or disturbance of these soils. The areas that will be subject to Institutional Controls, based on available data, are shown of **Figure 4.4-2.**

Excavated soil would be shipped off-site for disposal and the excavations would be backfilled with soil of appropriate quality that had similar properties as the excavated soil or a compensatory wetland mitigation will need to be completed.

Components of Alternative WSS 2

The scope of the alternative includes the following major components:

- Institutional controls
- Pre-design investigations and design
- Temporary storm water control and diversion
- Excavation of chromium- and/or BEHP-impacted wetland soil and sediments
- Stabilization and off-site disposal of excavated soil
- Backfill and restoration
- Environmental Monitoring
- Reporting
- Five-year Site reviews

Overall Estimated Duration for the Alternative

The overall project duration is estimated to take approximately 22 months, summarized as follows:

- Pre-design work plan, sampling and analyses 8 months
- Design 3 months
- Contracting and On-site remedial activities 5 months
- Soil Management Plan 3 months
- Reporting 2 months

In addition, five-year Site reviews would be conducted as required under CERCLA. For cost estimating purposes, this alternative assumes that five-year Site reviews would be conducted for 30 years.

This remedy will be implemented after it is established that discharge from impacted groundwater is not serving as an on-going source which could negatively impact the quality of wetland soils and sediment.

Institutional controls

ICs would be implemented through measures that may include, but not limited to, a local town ordinance, a NAUL, or a GERE. Institutional controls could include a deed restriction and associated Soil Management Plan that would provide strict requirements to minimize excavation of soil in areas shown in **Figure 4.4-2** below 1 foot bgs which exceed the PRGs of chromium and/or BEHP. The objective of the Soil Management Plan would be to prevent impacted subsurface soil from being brought to and left at the surface, where it could cause ecological receptor exposure.

Pre-design investigations and design

Prior to conducting a pre-design investigation, the current extent of wetland delineation at the Site will be confirmed through site reconnaissance and evaluation by a qualified wetlands soil scientist. Pre-design investigations will consist of hand auguring (or equivalent) approximately 30 locations to 1 foot bgs and analyzing for total chromium and BEHP to confirm the limits in wetland soil that require remediation. For cost estimating purposes, the field effort for this investigation is anticipated to be completed in five days. The pre-design investigation data would be evaluated to determine the actual extent of areas that would require remediation.

A remedial design would be prepared to provide detailed drawings and specifications for how and where the areas of soil excavation would be conducted. A detailed storm water pollution prevention plan (SWPPP) will be included in the design package to protect surrounding un-impacted areas during wetlands soil/sediment excavation.

Temporary Storm Water Control and Diversion

Temporary stormwater controls may be required during remedy implementation to minimize the amount of soil that requires stabilization and to facilitate excavation. Depending on the season, temporary stormwater diversions may be needed to excavate portions of the South ditch and Off-Property West Ditch. The water in South Ditch or Off-Property West Ditch would be temporarily diverted to facilitate sediment and soil removal in relatively dry conditions.

Temporary measures will be installed upgradient to divert surface water flow as necessary. Water diversion would be accomplished by using a temporary dam(s), such as sand-filled super sack or water-filled bladder, to control the surface water flow. The pooled water would be pumped through an on-site treatment system consisting of bag filters and, if necessary, granular activated carbon and then discharged at the downstream edge of the respective ditch. These diversions would be temporarily constructed on an as needed basis and sequenced in such a way that a portion of the ditch is excavated and backfilled while the diversion is in place. Seepage for groundwater and adjacent soils is expected to occur at relatively slow rates and may not require additional dewatering measures.

The central pond will require dewatering before excavating the sediment from this area. Approximately 640,000 gallons of recovered water would be treated locally through the on-site treatment system to be installed as part of the Groundwater Hot Spots remedy described in the IAFS. It is assumed that discharge of the wastewater from dewatering activities will meet the requirements of the groundwater extraction system operating at the Site.

Excavation of chromium- and BEHP-impacted soil

This is the same remediation method used during the 2000-2001 remediation of sediments in the Upper South Ditch, on-PWD, on-PWD Wetland, and Central Pond.

The excavation limits would be based on the pre-design investigation results. For purposes of costing and overall alternative evaluation, the proposed remediation areas shown on **Figure 4.4-1** would be excavated to a depth of 1 foot bgs. For estimating purposes the total area was estimated at 106,500 square feet which yields approximately 5,000 loose cubic yards of excavated wetland soil and sediment.

The proposed remediation areas for sediment includes the entire length of Upper and Lower South Ditch and Central Pond and the northern half of Off-Property West Ditch. The proposed remediation areas for wetland soil include the Lower South Ditch and EA5, eastern portion of EA2, and six hotspot locations in EA4 and EA6.

Access to the contaminated sediments and wetland soils in the Upper South Ditch and Central Pond would be via the former access road entrance near GW-79S and would follow the route of the original haul road access that was constructed and used during the 2000 – 2001 sediment remediation project. A new haul road approximately 650 feet in length would be constructed on the northern side of the south ditch from the Central Pond downstream to the Property boundary and eventually close to East Ditch. Approximately 250 feet of haul road will need to be constructed to access the hot spot located south of the South ditch in EA4. All other excavation areas are accessible by existing roads.

Prior to excavation, the remedial areas will be cleared of trees and vegetation. The contaminated sediment and soil would be excavated using low ground pressure soft terrain earthmoving equipment and loaded into vacuum boxes, or similar, to partially dewater. The soil would then be loaded from the vacuum box into trucks and transported to a staging area in the former plant site. The location of the staging area would depend on other remediation projects that might be on-going at the time and the portions of the former plant area that might be available for this staging area. The location and size of the staging area would be determined during remedial design. The staging area would include a temporary containment berm for stabilization of the excavated material for transportation or disposal purposes.

Dewatering/Stabilization and off-site of excavated soil

For cost estimating purpose, this alternative assumes all of the excavated soil and sediment would require stabilization prior to off-site disposal to reduce the water content of the soil, which will also reduce leachability of the contaminants. It is anticipated that recovered water would be captured and filtered before being treated through an on-site treatment system. Soil would be stabilized using Portland cement, lime, or another suitable stabilizing agent. The stabilized soil would be trucked off-site for disposal at a Subtitle D facility as non-hazardous waste. Approximately 4,000 in-place cubic yards of soil would be excavated and stabilized on-site. Therefore, it is estimated that approximately 6,200 tons of excavated soil would be shipped off-site for disposal.

Backfill and restoration

The sediment excavation areas would be backfilled with off-site borrow material that is verified to meet appropriate guidelines. The excavation areas would be backfilled to generally match pre-excavation conditions, using granular soil material within the stream channel in the South Ditch and Off-Property West Ditch, and dressed with an organic top soil in adjacent forested wetland area. Upon completion of the excavation, erosion blankets will be installed on channel banks where applicable and wetland grass varieties will be seeded. Temporary erosion controls best management practices would be instituted until such time as natural systems recover, which should be within a season or two due to the minimal disturbance in the surrounding ecological system.

The excavated wetland areas would be backfilled and re-vegetated in accordance with a wetland restoration plan. The wetland soil excavation areas would be backfilled with off-site borrow material that is verified to meet appropriate guidelines. The wetland soil areas would be backfilled to match pre-excavation conditions generally, using granular soil material and dressed with an organic top soil. Best management practices to control erosion and sedimentation would be maintained until vegetation is reestablished.

Environmental monitoring

Periodic inspections would be conducted at the remediation areas to monitor and evaluate the recovery of the ecological environment associated with these areas of the OCSS. It is assumed that these inspections would be conducted monthly for the first six months, and semi-annual thereafter until recovery has been established (1-2 years). These periodic inspections would be documented in routine reporting submitted to the USEPA.

Reporting

A Remedial Action Report would be prepared to document the remedial action, including but not limited to the final excavation limits, on-site stabilization efforts, waste disposal information, and implementation of the Institutional Controls.

Five-year site reviews

CERCLA requires that any remedial action that results in contaminants remaining on-site at concentrations above those allowing for unlimited exposure and unrestricted use (i.e., residential development, school or daycare facility) must be reviewed at least every five years. During five-year site reviews, an assessment is made as to whether the implemented remedy continues to be protective of human health and the environment, or whether the implementation of additional remedial action is appropriate. The USEPA document Comprehensive Five-Year Review Guidance (USEPA, 2001) provides guidance on the performance of five-year reviews.

This alternative includes excavating areas of wetland soil and sediment with chromium and BEHP concentrations above PRGs up to 1 foot bgs, but also includes Institutional Controls for soils deeper than 1 foot bgs. Therefore, five-year reviews will be conducted as required under CERCLA. For cost estimating purposes, this alternative assumes five-year reviews to be conducted for 30 years.

4.4.1.1 Alternative WSS 2 Overall Protection of Human Health and the Environment

This alternative would be protective of human health and the environment by physically removing shallow wetland soil and sediment thereby eliminating the exposure pathway to ecological receptors and prohibiting the disturbance of deeper soils with chromium and/or BEHP concentrations above PRGs, thereby also reducing future potential risk to human receptors. Therefore, this alternative would achieve the RAO of preventing exposure by current and future ecological receptors to surface and subsurface soil (up to 10 feet deep) containing chromium and/or BEHP that would result in potential adverse impacts.

4.4.1.2 Alternative WSS 2 Compliance with ARARs

The location-, chemical-, and action-specific ARARs that are applicable to the chromium and BEHP in sediment and wetland soil alternatives are identified in **Tables 2.1-7 through 2.1-9**. The applicability of the individual ARARs with respect this alternative, and how the alternative will comply with the ARAR is identified in these tables.

The proposed remediation areas for this alternative are located within a designated wetland and within a 500-year floodplain. Restoration activities for any areas that may be impacted would be implemented to comply with location-specific ARARs identified in **Table 2.1-7**, such as compensatory wetlands mitigation, to comply with Clean Water Act Section 404 and the Massachusetts Wetland Protection Act, which have been identified as applicable location-specific requirements. If temporary impacts to the floodplain are found to be unavoidable while implementing the cleanup actions, appropriate measures will be incorporated into the cleanup design and subsequently implemented during the Remedial Action phase to ensure that current flood storage capacities (and flood stages or velocities) and any adjacent wetlands are not affected during and after completion of the proposed remedial actions. BMPs will be used during the construction phase, which include erosion control measures, proper regrading, and restoration and monitoring of impacted areas.

No applicable or relevant and appropriate chemical-specific requirements have been identified for this alternative. However, site-specific PRGs have been developed to comply with the chemical-specific ARARs presented in **Table 2.1-8**, including but not limited to USEPA risk assessment guidance documents.

This alternative would be designed and implemented to comply with the action-specific ARARs identified in **Table 2.1-9**, including but not limited to, RCRA Subtitle C regulations related to soil characterization and waste identification requirements. This alternative assumes that none of the excavated soil or sediment will exhibit chromium and BEHP concentrations that may result in being characterized as a hazardous waste. However, the excavated soil would be analyzed to determine whether the material may be classified as a characteristic hazardous waste. If any hazardous waste is generated during the remedial action, it would be handled, stored, tracked, and disposed of in accordance with the various requirements of RCRA Subtitle C and

Massachusetts Hazardous Waste Rules, both of which have been identified as applicable action-specific requirements for this alternative.

4.4.1.3 Alternative WSS 2 Long-term Effectiveness and Permanence

This alternative would provide long-term effectiveness by permanently removing chromium and BEHP at concentrations above PRGs from wetland soil and sediment areas to a depth of 1 foot bgs. Institutional controls would be implemented that would prohibit future excavation of soil below 1 foot bgs. Removing chromium- and BEHP-impacted soil would mitigate potential future risks to ecological receptors. Prohibiting excavation of contaminated deeper soils would prevent potential future exposures of human receptors since those soils would not be brought to a more shallow depth thereby providing long-term effectiveness and permanence.

Completion of the on-site activities from pre-design investigations through remedial activities, verification sampling, and reporting, are estimated to take approximately 22 months. This would be followed by two years of semi-annual monitoring to evaluate the recovery of the ecological environment associated with this area of remediation and wetland restoration. Additionally, five-year reviews would be conducted as required under CERCLA.

4.4.1.4 Alternative WSS 2 Reduction of Toxicity, Mobility, or Volume through Treatment

This alternative would involve physical removal of wetland soil and sediment with chromium and BEHP concentrations above PRGs as shown on **Figure 4.4-1**. Physical removal of these soils would reduce the mass of chromium and BEHP in wetland soil and sediment in these areas of the Site. Based on available Site data, an estimated 22,130 pounds (approximately 11 tons) of chromium and estimated 560 pounds of BEHP (approximately 0.30 tons) are associated with the estimated 4,000 cubic yards (approximately 6,200 tons) of wetland soil and sediment proposed to be excavated and disposed as part of this remedial alternative.

Approximately 5,000 loose cubic yards of excavated soil would be treated on-site by adding a stabilizing agent such as Portland cement, prior to being transported off-site for disposal. Therefore, this alternative also reduces the mobility of contaminants with respect to the disposed material.

This alternative involves on-site stabilization to treat the excavated soil prior to off-site disposal (i.e., the contaminants are chemically immobilized by processes that reduce the leachability of the contaminants, and the immobilization of contaminants is irreversible). Therefore, this alternative satisfies the statutory preference for treatment as a principal element.

4.4.1.5 Alternative WSS 2 Short-term Effectiveness

This alternative would involve excavation, treatment, and off-site disposal, which would be effective at removing chromium and BEHP from wetland soil and sediments in the areas of the Site shown on **Figure 4.4-1** and prohibit the disturbance of deeper soil through institutional controls. This alternative would prevent ecological receptor exposure to wetland soil and sediment containing chromium and/or BEHP that would result in potential adverse impacts. Therefore, this alternative would provide short-term effectiveness upon completion of construction-related activities, which is estimated to be approximately 22 months. Potential short-term risks to on-site workers involved in the remedial activities would be minimized by conducting the work in accordance with a site-specific HASP. Potential short-term risks to the community would be addressed by minimizing dust, decontaminating vehicles transporting excavated soil prior to leaving the Site, and minimizing vehicular traffic associated with the remediation effort from traveling through residential areas.

4.4.1.6 Alternative WSS 2 Implementability

The major components of this alternative are excavation, on-site treatment (soil stabilization), and off-site disposal. The technologies used for this alternative are generally implementable, readily available, and sufficiently demonstrated for use at the Site. The alternative would use standard construction equipment, and the equipment, materials, and disposal facility are readily available.

Access to the contaminated sediments and wetland soils in the upper South Ditch and Central Pond would be via the existing access road entrance near GW-79S and would follow the original haul road access that was constructed and used during the 2000 – 2001 sediment remediation project. A new haul road approximately 650 feet in length would be constructed on the northern side of the south ditch from the Central Pond downstream to the Property boundary and eventually close to East Ditch. Approximately 250 feet of haul road will need to be constructed to access the hot spot located south of the South ditch in EA4. All other excavation areas are accessible by existing roads. Restoration activities for any haul road constructed in wetlands will need to be restored or have compensatory wetlands mitigation, to comply with Clean Water Act Section 404 and the Massachusetts Wetland Protection Act and may require coordination with United States Army Corp of Engineers.

In all of the remedial areas, partial dewatering will be required before the soil is transported to the staging area for stabilization. The recovered water would be treated locally at the excavation through a treatment system consisting of bag filters and granular activated carbon.

Discharge of the wastewater from dewatering activities will minimally need to meet the substantive NPDES requirements.

4.4.1.7 Alternative WSS 2 Cost

The cost estimate for this alternative is presented in **Table 4.4-1** and includes the following major components:

- Institutional controls
- Pre-design investigations
- Design
- Temporary storm water control and diversion
- Excavation of chromium- and/or BEHP-impacted wetland soil and sediments
- Stabilization and off-site disposal of excavated soil
- Backfill and restoration
- Environmental Monitoring
- Reporting
- Soil Management Plan
- Five-year site reviews

The estimated time to complete the on-site remedial activities associated with this alternative is approximately 5 months, and the overall duration of this remedy (including predesign, design, remedial activities, and reporting) is estimated to be approximately 22 months. In order to prevent potential recontamination of wetland soils and sediments, it is assumed that this remedy will be implemented after implementation of the selected Surface Water alternative and demonstration that impacted groundwater is not negatively impacting the quality of wetland soils and sediment.

Costs for excavation, soil stabilization, off-site disposal, backfill, and restoration were provided by environmental remediation contractors. Costs associated with pre-design investigations, design, verification sampling, and reporting are based on costs for similar projects. Net present worth cost was calculated based on a 7% annual discount rate.

The cost estimate for this alternative, presented in **Table 4.4-1**, is summarized as follows:

Alternative WSS 2: Excavation and Off-Site Disposal	
Capital Cost	$2,342,000
O&M Cost	$240,000
Total Cost	$2,582,000
Net Present Worth	$2,439,000
Overall Alternative Duration	30 years

4.5 Surface Water Alternatives

This section presents the detailed analysis for the following remedial alternatives for surface water:

Alternative SW 2: Limited Action – Surface Water and Groundwater Monitoring
Alternative SW 3: Groundwater Extraction and Treatment
Alternative SW 4: Targeted Groundwater Extraction and Treatment
Alternative SW 5: PRB
Alternative SW 6: Targeted Approach for PRB Installation

4.5.1 Alternative SW 2: Limited Action – Surface Water and Groundwater Monitoring

This alternative consists of long-term semi-annual monitoring of monitoring wells and surface water sampling points. **Figure 4.5-1** shows the proposed 7 surface water and 22 groundwater monitoring locations.

This alternative would consist of the following components:

- Semi-annual groundwater and surface water monitoring and reporting
- 5-Year Reviews

<u>Overall Estimated Duration for the Alternative</u>

For cost estimating purposes, the overall project duration is assumed to take thirty years, during which time groundwater and surface water monitoring would be conducted on a semi-annual basis. However, remedy optimization may allow for some locations to be removed from the monitoring program or for the sample frequency and/or analytical parameters being monitored to be reduced over time.

Semi-Annual Groundwater and Surface Water Monitoring and Reporting

For cost estimating purposes, groundwater and surface water is assumed to be monitored for 30 years. Semi-annual monitoring would be conducted at 7 surface water and 22 groundwater monitoring locations as shown on **Figure 4.5-1**. For cost estimating purposes, all surface water and groundwater samples would be analyzed for ammonia, NDMA, sulfate, TMPs, BEHP, PAHs and metals (i.e., aluminum, chromium, iron, lead, and zinc). The full list of compounds that surface water and groundwater samples will be analyzed for will be consistent with the quarterly groundwater monitoring program initiated in the first quarter 2020. The monitoring results would be documented in annual monitoring reports. Remedy optimization may allow for some locations to be removed from the monitoring program or for the sample frequency and/or number of analytical parameters being monitored to be reduced over time.

Five-year site review

CERCLA requires that any remedial action that results in contaminants remaining on-site at concentrations above those allowing for unlimited exposure and unrestricted use must be reviewed at least every five years. During five-year site reviews, an assessment is made as to whether the implemented remedy continues to be protective of human health and the environment, or whether the implementation of additional remedial action is appropriate. The USEPA document Comprehensive Five-Year Review Guidance (USEPA, 2001) provides guidance on the performance of five-year reviews. Remedy optimization would be evaluated as part of the five-year review, which may allow for some locations to be removed from the monitoring program or for the sample frequency and/or number of analytical parameters being monitored to be reduced over time.

4.5.1.1 Alternative SW 2 Overall Protection of Human Health and the Environment

This alternative is not fully protective of human health and the environment. Alternative SW 2 would not prevent exposure of current and future ecological receptors to surface water containing Site contaminants that would result in potential adverse impacts in surface water. This alternative would monitor the concentrations of ammonia, NDMA, sulfate, TMPs, BEHP, PAHs and metals (i.e., aluminum, chromium, iron, lead, and zinc) but would not treat the groundwater or surface water entering South Ditch or the off-PWD.

4.5.1.2 Alternative SW 2 Compliance with ARARs

The location- and action-specific ARARs that are applicable to the surface water alternatives are identified in **Tables 2.1-10 through 2.1-11**. The applicability of the individual ARARs with respect this alternative, and how the alternative will comply with the ARAR is identified in these tables.

The on-site activities associated with this alternative involve semi-annual monitoring of various surface water and groundwater locations. There are no active, invasive activities associated with this alternative, and therefore, the location-specific ARARs identified in **Table 2.1-10** are not applicable.

This alternative would be designed and implemented to comply with the applicable action-specific ARARs identified in **Table 2.1-11** of the OU1/OU2 FS. As presented in **Table 2.1-11** of the OU1/OU2 FS, the National Recommended Water Quality Criteria (NRWQC) were considered during development of site-specific PRGs for COCs in surface water. In addition, for the off-PWD, human health risk assessment TBCs were considered during development of the site-specific PRGs for COCs in surface water. Surface water in South Ditch and Off-Property West Ditch does not currently meet these site-specific PRGs, which will be used to monitor surface water, and this alternative does not provide remedial actions to reduce concentrations.

4.5.1.3 Alternative SW 2 Long-term Effectiveness and Permanence

This alternative is not effective at mitigating risk to human health and the environment in the long-term. Surface water in South Ditch and the off-PWD does not currently meet PRGs, and this alternative does not immediately provide remedial actions to reduce concentrations. This alternative does, however, provide long-term natural attenuation and monitoring to evaluate the effectiveness of the alternative and to evaluate downward trends in contaminant concentrations.

For cost estimating purposes, semi-annual surface water and groundwater monitoring is assumed to continue for 30 years. However, remedy optimization may allow for some locations to be removed from the monitoring program or for the sample frequency and/or number of analytical parameters being monitored to be reduced over time.

For cost estimating purposes, semi-annual surface water and groundwater monitoring is assumed to continue for 30 years. However, remedy optimization may allow for some locations to be removed from the monitoring program or for the sample frequency and/or number of analytical parameters being monitored to be reduced over time.

4.5.1.4 Alternative SW 2 Reduction of Toxicity, Mobility, or Volume through Treatment

This alternative provides no treatment or removal of Site COCs and therefore does not reduce the toxicity, mobility, or volume of Site COCs in groundwater and surface water.

4.5.1.5 Alternative SW 2 Short-term Effectiveness

This alternative is not effective at mitigating risk to human health and the environment in the short-term. Surface water in South Ditch and the off-PWD does not currently meet PRGs, and this alternative does not provide remedial actions to reduce concentrations. This alternative does provide long-term monitoring to evaluate the effectiveness of the alternative.

4.5.1.6 Alternative SW 2 Implementability

The major components of this alternative are groundwater/surface water monitoring. The alternative would use standard equipment, and the equipment and materials are readily available.

4.5.1.7 Alternative SW 2 Cost

The cost estimate for this alternative is presented in the attached **Table 4.5-1** and includes the following major components:

- Semi-annual groundwater and surface water monitoring and reporting
- Five-year reviews

This alternative does not require on-site construction work. For cost estimating purposes, the overall duration of this remedy is assumed to be 30 years.

The cost estimate for this alternative, presented in the attached **Table 4.5-1**, is summarized as follows:

Alternative SW 2: Limited Action – Surface Water and Groundwater Monitoring	
Capital Cost	$0
O&M Cost	$2,267,000
Total Cost	$2,267,000
Net Present Worth	$1,551,000
Overall Alternative Duration	30 years

4.5.2 Alternative SW 3: Groundwater Extraction and Treatment

This alternative includes installation of a series of groundwater extraction wells at locations upgradient (west and northwest) of the weir at the upstream location of South Ditch adjacent to the off-PWD, and one groundwater extraction well midway along South Ditch between the weir and discharge location where South Ditch meets East Ditch. The alternative also includes installation of a series of groundwater extraction wells along East Ditch from just south of Plant B downstream to just south of the confluence with South Ditch and the Ephemeral Drainage.

Extracted groundwater would be conveyed to the new treatment plant proposed to be constructed as part of the groundwater remediation alternatives. The treated groundwater would then be discharged to surface drainage; a portion of treated groundwater would be discharged to the northern portion of East Ditch and the remaining would be discharged to the upstream portion of South Ditch. Proposed extraction well and piping locations, as well as the proposed location of the treatment plant associated with the groundwater remedial alternatives are shown on **Figure 4.5-2**. The estimated time to complete construction of the extraction and treatment system is approximately six months. It is assumed that the extraction and treatment system would operate for 30 years. However, evaluation of long-term monitoring data may indicate attainment of RAOs in a timeframe shorter than 30 years. Remedy optimization, such as modifying the number of extraction wells, adjusting the extraction pumping rates, and/or changes to the monitoring program, would be evaluated as part of the annual monitoring report and the five-year review process.

This alternative would consist of the following components:

- Pre-design and design
- Installation of extraction well fences

- Installation of conveyance piping
- Treatment of extracted groundwater
- Discharge of treated groundwater
- O&M of the groundwater extraction system
- Monitoring
- Five-year reviews

Overall Estimated Duration for the Alternative

The overall project duration is assumed to be 30 years, summarized as follows:

- Pre-design and design 6 months
- On-site remedial activities 6 months
- Operation of Groundwater Extraction/Treatment System 30 years

Pre-design and design

Pre-design activities would be conducted as necessary to support identification of extraction well and underground piping locations. The pre-design investigations may include a geophysical survey, additional surface water sampling, and evaluation of potential groundwater seep locations, as well as a shallow groundwater hydrology evaluation to locate and design the proposed extraction wells. This information would be used to design the extraction wells and piping system.

Installation of extraction wells

Three extraction wells would be installed upgradient (west and northwest) of the weir at the western end of South Ditch and adjacent to the off-PWD. One additional groundwater extraction well is proposed midway along South Ditch between the weir and confluence where South Ditch meets East Ditch, to the northeast of PZ16RR. This extraction well would intercept Site COCs present in groundwater to the east/southeast of the containment area. Proposed extraction well locations are shown on **Figure 4.5-2**. The three extraction wells near the weir are expected to operate at approximately 5 gpm per well and the single extraction well northeast of PZ-16RR would operate at approximately 10 gpm.

The East Ditch extraction well fence would be installed along the west side of East Ditch from Plant B to just south of the confluence of East Ditch and South Ditch. Seventeen extraction wells are proposed for installation spaced approximately 100-feet apart. Proposed extraction well locations are shown on **Figure 4.5-2**. These extraction wells are expected to operate at approximately 10 gpm per well.

Installation of conveyance piping

Conveyance piping would be installed to transport extracted groundwater to the new treatment system. All conveyance piping is assumed to be underground. Proposed piping locations are shown on **Figure 4.5-2**.

Treatment of extracted groundwater

The proposed new treatment plant would include pretreatment, breakpoint chlorination, solids handling, and ultra violet (UV)/oxidation to treat Site COCs, including chromium and ammonia, the COCs associated with East Ditch and South Ditch surface water. Treatment system construction costs are reflected in the cost table for the groundwater hot spot alternative presented in the IAFS Report.

Discharge of treated groundwater

Treated water would be discharged to surface drainage at upstream locations in East Ditch and South Ditch.

O&M

O&M of the groundwater extraction and treatment system is assumed for 30 years. However, evaluation of long-term monitoring data may indicate attainment of RAOs in a timeframe shorter than 30 years. Remedy optimization, such as modifying the number of extraction wells, adjusting the extraction pumping rates, and/or changes to the monitoring program, would be evaluated as part of the annual monitoring report and the five-year review process.

O&M on the groundwater extraction system is reflected in the SW 3 Cost Table, and is assumed to include cleaning, flushing, and/or rehab of the extraction wells every five years. More specific details of the O&M program would be identified during development of the remedial design. O&M for the treatment system is reflected in the cost table for the groundwater hot spot alternative presented in the IAFS Report.

Monitoring

Monitoring associated with this alternative would include semi-annual monitoring of 7 surface water and 12 groundwater monitoring locations as shown on **Figure 4.5-2**. Additionally, sampling and analysis of groundwater samples from each proposed extraction well would be conducted on an annual basis. All groundwater and surface water samples would be analyzed for ammonia, NDMA, sulfate, TMPs, BEHP, PAHs and metals (i.e., aluminum, chromium, iron, lead, and zinc). This monitoring program is assumed to continue for 30 years. However, evaluation of long-term monitoring data may indicate attainment of RAOs in a timeframe shorter than 30 years. Remedy optimization, such as modifying the number of extraction wells, adjusting the extraction pumping rates, and/or changes to the monitoring program, would be evaluated as part of the annual monitoring report and the five-year review process.

Five-year site review

CERCLA requires that any remedial action that results in contaminants remaining on-site at concentrations above those allowing for unlimited exposure and unrestricted use must be reviewed at least every five years. During five-year site reviews, an assessment is made as to whether the implemented remedy continues to be protective of human health and the environment, or whether the implementation of additional remedial action is appropriate. The USEPA document Comprehensive Five-Year Review Guidance (USEPA, 2001) provides guidance on the performance of five-year reviews. Remedy optimization, such as modifying the number of extraction wells, adjusting the extraction pumping rates, and/or changes to the monitoring program, would be evaluated as part of the annual monitoring report and the five-year review process.

4.5.2.1 Alternative SW 3 Overall Protection of Human Health and the Environment

This alternative is protective of human health and the environment. Alternative SW 3 would extract and treat the groundwater containing COCs prior to its discharge to East Ditch, South Ditch, and Off-PWD; therefore, it would prevent exposure of current and future ecological receptors to surface water containing COCs that would result in potential adverse impacts.

4.5.2.2 Alternative SW 3 Compliance with ARARs

The location- and action-specific ARARs that are applicable to the surface water alternatives are identified in **Tables 2.1-10 through 2.1-11**. The applicability of the individual ARARs with respect this alternative, and how the alternative will comply with the ARAR is identified in these tables.

This alternative would be designed and implemented to minimize potential impacts to nearby wetland areas. Restoration activities for any areas that may be impacted would be implemented to comply with location-specific ARARs identified in **Table 2.1-10**, such as compensatory wetlands mitigation, if necessary, to comply with Clean Water Act Section 404 and the Massachusetts Wetland Protection Act, which have been identified as applicable location-specific requirements.

This alternative would be designed and implemented to comply with the action-specific ARARs identified in **Table 2.1-11** of the OU1/OU2 FS, including but not limited to, NPDES and Clean Water Act (CWA) Toxic Pollutant Effluent Standards. Discharge of treated water to East Ditch and South Ditch would be required to meet these effluent and discharge requirements. As presented in **Table 2.1-11** of the OU1/OU2 FS, the National Recommended Water Quality Criteria (NRWQC) were considered during development of site-specific PRGs for COCs in surface water. In addition, for the off-PWD, human health risk assessment TBCs were considered during development of the site-specific PRGs for COCs in surface water. These site-specific PRGs will be used to monitor surface water to ensure that the groundwater extraction and treatment are successful in reducing contaminant levels in surface water to be protective of ecological receptors.

4.5.2.3 Alternative SW 3 Long-term Effectiveness and Permanence

This alternative is effective at mitigating risk to human health and the environment in the long-term. Groundwater treatment permanently removes Site COCs from groundwater. Long-term groundwater and surface water sampling would be performed to verify achievement of PRGs and long-term protection of human health and the environment. Once Site COCs in groundwater meet PRGs, no residual unacceptable risk to human health and the environment will remain from groundwater or surface water in South Ditch, East Ditch, and Off-PWD.

Completion of the remedy from pre-design investigations through construction and operation, is estimated to take approximately 30 years. However, evaluation of long-term monitoring data may indicate attainment of RAOs in a timeframe shorter than 30 years. Remedy optimization, such as modifying the number of extraction wells, adjusting the extraction pumping rates, and/or changes to the monitoring program, would be evaluated as part of the annual monitoring report and the five-year review process.

4.5.2.4 Alternative SW 3 Reduction of Toxicity, Mobility, or Volume through Treatment

This alternative would involve treatment of extracted groundwater and would reduce the toxicity, mobility, and volume of Site COCs in groundwater. The new treatment plant would include pretreatment, breakpoint chlorination, solids handling, and UV/oxidation to treat Site COCs, including chromium and ammonia, the COCs associated with surface water. Treatment would be irreversible, and treated water would be discharged back to East Ditch and South Ditch. Over time, COCs in surface water will be expected to diminish in concentrations below PRGs such that no unacceptable risks to human health and the environment will remain with respect to groundwater sources to surface water. This alternative satisfies the statutory preference for treatment as a principal element.

Waste materials would be generated during the groundwater treatment process, including solids from the plate filter press and GAC associated with the UV/oxidation unit. These waste materials would be characterized and transported off-site for disposal.

An assessment of mass flux for chromium and ammonia was conducted by dividing each of the extraction well fences into sections and evaluating the most recent analytical data available for the existing monitoring wells in the vicinity of the proposed extraction wells. To account for dilution and contaminant attenuation over time, the initial contaminant concentrations were reduced to 20% based on an estimated one year of pumping to achieve removal of one pore volume. The long-term concentrations were then used along with the estimated flow rates of the proposed extraction wells to calculate the estimated mass flux. This approach is based on the National Institute of Health Manuscript "Assessing Contaminant-Removal Conditions and Plume Persistence through Analysis of Data from Long-term Pump-and-Treat Operations (Brusseau and Guo; August 2014).

In South Ditch, 3 wells pumping at 5 gpm each and 1 well pumping at 10 gpm were assumed. Average initial concentrations were taken from monitoring data in the closest available wells: PZ-18R, GW-39, GW-25, GW-202S, GW-202D, and GW-201S. Where the analyte was not detected, the full detection limit was used as the initial concentration. These wells are also assumed to address potential discharge of groundwater to the off-PWD.

In East Ditch, 17 wells pumping at 10 gpm were assumed. Average initial concentrations were taken from monitoring data in the closest available wells: GW-50S, GW-50D, GW-17S, GW-17D, GW-4, GW-3S, GW-3D, GW-52S, and GW-52D.

The mass fluxes for chromium and ammonia were calculated by multiplying the assumed well flow rates by the calculated long-term concentrations. The fluxes for individual wells were then summed and are presented below:

<u>South Ditch and off-PWD (3 wells at 5gpm plus 1 well at 10 gpm)</u>

- Estimated chromium mass flux is approximately 0.003 pounds per day (lbs/day)
- Estimated ammonia mass flux is approximately 5 lbs/day

<u>East Ditch (17 wells at 10 gpm)</u>

- Estimated chromium mass flux is approximately 0.001 lbs/day

- Estimated ammonia mass flux is approximately 4 lbs/day

4.5.2.5 Alternative SW 3 Short-term Effectiveness

This alternative is effective at mitigating risk to human health and the environment in the short-term; however, it should be noted that groundwater extraction and treatment remedies often have diminishing effectiveness over the course of their implementation. Initially higher mass removal rates may decline and become asymptotic once the COC mass has been removed from high permeability materials and mass removal becomes dominated by the small-scale processes of desorption, diffusion, or dissolution. Typically, COC removal rates are higher at the outset of groundwater extraction and treatment remedies, with diminishing returns over time.

Remedy construction is expected to take six months, and remedy operation is expected to take 30 years. During the six-month timeframe of remedy implementation, potential short-term risks to the community would be low. IDW generated during the installation of extraction wells would be containerized on-site and disposed of in accordance with RCRA requirements. Potential short-term risks to Site workers during remedy construction would be addressed through development of a site-specific Health and Safety Plan that adheres to OSHA requirements, including appropriate PPE and air monitoring plans.

Short-term risks to the community during the duration of the remedy's operation would be low. Institutional controls such as fencing and signs would prevent unauthorized or accidental entry to the operational areas. Short-term risks during the duration of the remedy's operation would include risks to on-site workers, which would be addressed via a site-specific Health and Safety Plan that adheres to OSHA requirements, including appropriate PPE and air monitoring plans.

4.5.2.6 Alternative SW 3 Implementability

The major components of this alternative are groundwater extraction and treatment. The alternative would use standard construction equipment, and the equipment, materials, and disposal facility for IDW are readily available.

Pre-design investigation activities would include verification of the locations of subsurface utilities that may be present within the proposed extraction well installation areas. No right-of-way or other infrastructure concerns are present in the proposed extraction well installation areas.

Semi-annual groundwater sampling is proposed to monitor the progress of the extraction and treatment remedy.

4.5.2.7 Alternative SW 3 Cost

The cost estimate for this alternative is presented in the attached **Table 4.5-2** and includes the following major components:

- Pre-design and design
- Installation of extraction well fences
- Installation of conveyance piping
- Treatment of extracted groundwater
- Discharge of treated groundwater
- O&M of the groundwater extraction system
- Monitoring
- Five-year reviews

Note, costs associated with the construction and maintenance of treatment system are included in the cost table for the groundwater hot spot alternative. The estimated time to complete the on-site remedial activities associated with this alternative is approximately six months, and the overall duration of this remedy (including predesign, design, monitoring, and reporting) is estimated to be approximately 30 years. However, evaluation of long-term monitoring data may indicate attainment of RAOs in a timeframe shorter than 30 years. Remedy optimization, such as modifying the number of extraction wells, adjusting the extraction pumping rates, and/or changes to the monitoring program, would be evaluated as part of the annual monitoring report and the five-year review process.

The cost estimate for this alternative, presented in the attached **Table 4.5-2**, is summarized as follows:

Alternative SW 3: Groundwater Extraction and Treatment	
Capital Cost	$4,459,000
O&M Cost	$6,486,000
Total Cost	$10,945,000
Net Present Worth	$8,798,000
Overall Alternative Duration	30 years

4.5.3 Alternative SW 4: Targeted Groundwater Extraction and Treatment

This alternative includes installation of three groundwater extraction wells along the western Property boundary upstream of the weir and parallel to the off-PWD, and one groundwater extraction well to the north of South Ditch approximately midway between the weir and the confluence of East and South Ditch. Continued operation of Plant B is assumed for this alternative. If Plant B were to be shut down in the future, an evaluation of Site hydrogeology would be performed first.

Extracted groundwater would be conveyed to the new treatment plant proposed to be constructed as part of the groundwater remediation alternatives (presented in the IAFS Report). The treated groundwater would then be discharged to surface drainage; a portion of treated groundwater would be discharged to the northern portion of East Ditch and the remaining would be discharged to the upstream portion of South Ditch. Proposed extraction well and piping locations, as well as the proposed location of the treatment plant associated with the groundwater remedial alternatives are shown on **Figure 4.5-3**. The estimated time to complete construction of the extraction and treatment system is approximately three months. It is assumed that the extraction and treatment system would operate for 30 years. However, evaluation of long-term monitoring data may indicate attainment of RAOs in a timeframe shorter than 30 years. Remedy optimization, such as modifying the number of extraction wells, adjusting the extraction pumping rates, and/or changes to the monitoring program, would be evaluated as part of the annual monitoring report and the five-year review process.

This alternative would consist of the following components:

- Pre-design and design
- Installation of extraction wells
- Installation of conveyance piping
- Treatment of extracted groundwater
- Discharge of treated groundwater
- O&M of the groundwater extraction system
- Monitoring
- Five-year reviews

<u>Overall Estimated Duration for the Alternative</u>

The overall project duration is estimated to take approximately five years, summarized as follows:

- Pre-design and design 6 months

- On-site remedial activities 3 months
- Operation of Groundwater Extraction/Treatment System 30 years

Pre-design and design

Pre-design activities would be conducted as necessary to support identification of extraction well and underground piping locations. The pre-design investigations may include a geophysical survey, additional surface water sampling, and evaluation of potential groundwater seep locations, as well as a shallow groundwater hydrology evaluation to cite and design the proposed extraction wells. This information would be used to design the extraction wells and system, as well as identify locations for additional extraction wells, if warranted as a result of the outcome of the pre-design investigations.

Installation of extraction wells

Three groundwater extraction wells would be installed along the western Property boundary upstream of the weir and parallel to the off-PWD, and one groundwater extraction well would be installed to the north of South Ditch approximately midway between the weir and the confluence of East and South Ditch. This extraction well would intercept Site COCs present in groundwater to the east/southeast of the containment area. Proposed extraction well locations are shown on **Figure 4.5-3**. The three extraction wells upgradient of the weir and parallel to the off-PWD are expected to operate at approximately 5 gpm per well and the single extraction well north of South Ditch (southeast of the Containment Area) would operate at approximately 10 gpm.

Installation of conveyance piping

Conveyance piping would be installed to transport extracted groundwater to the new groundwater treatment system. All conveyance piping is assumed to be underground. Proposed piping locations are shown on **Figure 4.5-3.**

Treatment of extracted groundwater

The proposed Groundwater Hot Spot treatment plant (presented in the IAFS Report) would include pretreatment, breakpoint chlorination, solids handling, and UV/oxidation to treat Site COCs, including chromium and ammonia, the COCs associated with surface water. Treatment system construction costs are reflected in the cost table for the groundwater hot spot alternative, as presented in the IAFS Report.

Discharge of treated groundwater

The treated groundwater would then be discharged to surface drainage; a portion of treated groundwater would be discharged to the northern portion of East Ditch and the remaining would be discharged to the upstream portion of South Ditch.

O&M

O&M of the groundwater extraction and treatment system is assumed for 30 years. However, evaluation of long-term monitoring data may indicate attainment of RAOs in a timeframe shorter than 30 years. Remedy optimization, such as modifying the number of extraction wells, adjusting the extraction pumping rates, and/or changes to the monitoring program, would be evaluated as part of the annual monitoring report and the five-year review process.

O&M on the groundwater extraction system is reflected in the SW 4 Cost Table, and is assumed to include cleaning, flushing, and/or rehab of the extraction wells every five years. More specific details of the O&M program would be identified during development of the remedial design. O&M for the groundwater hot spot treatment system is reflected in the cost table for the groundwater hot spot alternative (see the IAFS Report).

Monitoring

Monitoring associated with this alternative would include semi-annual monitoring of 7 surface water and 12 groundwater monitoring locations as shown on **Figure 4.5-3**. Each proposed extraction well would also be sampled and analyzed on an annual basis. Groundwater and surface water samples would be analyzed for ammonia, NDMA, sulfate, TMPs, BEHP, PAHs, and metals (i.e., aluminum, chromium, iron, lead, and zinc). This monitoring program is assumed to continue for 30 years. However, evaluation of long-term monitoring data may indicate attainment of RAOs in a timeframe shorter than 30 years. Remedy optimization, such as modifying the number of extraction wells, adjusting the extraction pumping rates, and/or changes to the monitoring program, would be evaluated as part of the annual monitoring report and the five-year review process.

Five-year site review

CERCLA requires that any remedial action that results in contaminants remaining on-site at concentrations above those allowing for unlimited exposure and unrestricted use must be reviewed at least every five years. During five-year site reviews, an assessment is made as to whether the implemented remedy continues to be protective of human health and the environment, or whether the implementation of additional remedial action is appropriate. The

USEPA document Comprehensive Five-Year Review Guidance (USEPA, 2001) provides guidance on the performance of five-year reviews. Remedy optimization, such as modifying the number of extraction wells, adjusting the extraction pumping rates, and/or changes to the monitoring program, would be evaluated as part of the annual monitoring report and the five-year review process.

4.5.3.1 Alternative SW 4 Overall Protection of Human Health and the Environment

This alternative is protective of human health and the environment. Alternative SW 4 would extract and treat the groundwater containing COCs prior to discharge; therefore, it would prevent exposure of current and future ecological receptors to surface water containing COCs that would result in potential adverse impacts. Short-term continued operation of Plant B is assumed for this alternative. If Plant B were to be shut down in the future, an evaluation of Site hydrogeology would be performed first to ensure continued protection of human health and the environment.

4.5.3.2 Alternative SW 4 Compliance with ARARs

The location- and action-specific ARARs that are applicable to the surface water alternatives are identified in **Tables 2.1-10 through 2.1-11**. The applicability of the individual ARARs with respect to this alternative, and how the alternative will comply with the ARAR is identified in these tables.

This alternative would be designed and implemented to minimize potential impacts to nearby wetland areas. Restoration activities for any areas that may be impacted would be implemented to comply with location-specific ARARs identified in **Table 2.1-10**, such as compensatory wetlands mitigation, if necessary, to comply with Clean Water Act Section 404 and the Massachusetts Wetland Protection Act, which have been identified as applicable location-specific requirements.

This alternative would be designed and implemented to comply with the action-specific ARARs identified in **Table 2.1-11** of the OU1/OU2 FS, including but not limited to, NPDES and Clean Water Act (CWA) Toxic Pollutant Effluent Standards. Discharge of treated water to East Ditch and South Ditch would be required to meet these effluent and discharge requirements. As presented in **Table 2.1-11** of the OU1/OU2 FS, the National Recommended Water Quality Criteria (NRWQC) were considered during development of site-specific PRGs for COCs in surface water. In addition, for the off-PWD, human health risk assessment TBCs were considered during development of the site-specific PRGs for COCs in surface water. These site-specific PRGs will be used to monitor surface water to ensure that the groundwater extraction and treatment are successful in reducing contaminant levels in surface water to be protective of ecological receptors.

4.5.3.3 Alternative SW 4 Long-term Effectiveness and Permanence

This alternative is effective at mitigating risk to human health and the environment in the long-term. Groundwater treatment permanently removes Site COCs from groundwater. Long-term groundwater and surface water sampling would be performed to verify achievement of PRGs and long-term protection of human health and the environment. Once Site COCs in groundwater meet PRGs, no residual unacceptable risk to human health and the environment will remain in surface water.

Completion of the remedy from pre-design investigations through construction and operation, is estimated to take approximately 30 years. However, evaluation of long-term monitoring data may indicate attainment of RAOs in a timeframe shorter than 30 years. Remedy optimization, such as modifying the number of extraction wells, adjusting the extraction pumping rates, and/or changes to the monitoring program, would be evaluated as part of the annual monitoring report and the five-year review process.

4.5.3.4 Alternative SW 4 Reduction of Toxicity, Mobility, or Volume through Treatment

This alternative would involve treatment of extracted groundwater and would reduce the toxicity, mobility, and volume of Site COCs in groundwater. The proposed Groundwater Hot Spot treatment plant presented in the IAFS Report would include pretreatment, breakpoint chlorination, solids handling, and UV/oxidation to treat Site COCs, including chromium, ammonia and if necessary, benzo(a)pyrene, the COCs associated with surface water. Treatment would be irreversible, and treated water would be discharged back to East and South Ditch. Over time, COCs in surface water will be expected to diminish in concentrations below PRGs such that no unacceptable risks to human health and the environment will remain with respect to the groundwater sources to surface water. This alternative satisfies the statutory preference for treatment as a principal element.

Waste materials would be generated during the groundwater treatment process, including solids from the plate filter press and GAC associated with the UV/oxidation unit. These waste materials would be characterized and transported off-site for disposal.

An assessment of mass flux for the primary COCs (i.e., chromium and ammonia) was conducted by dividing the extraction well fence into sections and evaluating the most recent analytical data available for the existing monitoring wells in the vicinity of the proposed extraction wells. To account for dilution and contaminant attenuation over time, the initial contaminant concentrations were reduced to 20% based on an estimated one year of pumping to achieve removal of one pore volume. The long-term concentrations were then used along with the estimated flow rates of the proposed extraction wells to calculate the estimated mass flux. This approach is based on the National Institute of Health Manuscript "Assessing Contaminant-Removal Conditions and Plume Persistence through Analysis of Data from Long-term Pump-and-Treat Operations (Brusseau and Guo; August 2014). Because of the limited data available for benzo(a)pyrene (a COC specifically associated with the off-PWD), this compound was not included in mass flux calculations.

In South Ditch and the off-PWD, 3 wells pumping at 5 gpm each and 1 well pumping at 10 gpm were assumed. Average initial concentrations were taken from monitoring data in the closest available wells: PZ-18R, GW-39, GW-25, GW-202S, GW-202D, and GW-201S. Where the analyte was not detected, the full detection limit was used as the initial concentration.

The mass fluxes for chromium and ammonia were calculated by multiplying the assumed well flow rates by the calculated long-term concentrations. The fluxes for individual wells were then summed and are presented below:

<u>South Ditch and off-PWD (3 wells at 5gpm plus 1 well at 10 gpm)</u>

- Estimated chromium mass flux is approximately 0.003 pounds per day (lbs/day)
- Estimated ammonia mass flux is approximately 5 lbs/day

4.5.3.5 Alternative SW 4 Short-term Effectiveness

This alternative is effective at mitigating risk to human health and the environment in the short-term; however, it should be noted that groundwater extraction and treatment remedies often have diminishing effectiveness over the course of their implementation. Initially higher mass removal rates may decline and become asymptotic once the COC mass has been removed from high permeability materials and mass removal becomes dominated by the small-scale processes of desorption, diffusion, or dissolution. Typically, COC removal rates are high at the outset of groundwater extraction and treatment remedies, with diminishing returns over time.

Remedy construction is expected to take three months, and remedy operation is expected to take 30 years. During the three-month timeframe of remedy implementation, potential short-term risks to the community would be low. IDW generated during the installation of extraction wells would be containerized on-site and disposed of in accordance with RCRA requirements. Potential short-term risks to Site workers during remedy construction would be addressed through development of a site-specific Health and Safety Plan that adheres to OSHA requirements, including appropriate PPE and air monitoring plans.

Short-term risks to the community during the duration of the remedy's operation would be low. Institutional controls such as fencing and signs would prevent unauthorized or accidental entry to the operations areas. Short-term risks during the duration of the remedy's operation would include risks to on-site workers, which would be addressed via a site-specific Health and Safety Plan that adheres to OSHA requirements, including appropriate PPE and air monitoring plans.

4.5.3.6 Alternative SW 4 Implementability

The major components of this alternative are groundwater extraction and treatment. The alternative would use standard construction equipment, and the equipment, materials, and disposal facility for IDW are readily available.

Pre-design investigation activities would include verification of the locations of subsurface utilities that may be present within the proposed extraction well installation areas. No right-of-way or other infrastructure concerns are present in the proposed extraction well installation areas.

Semi-annual groundwater sampling is proposed to monitor the progress of the extraction and treatment remedy.

4.5.3.7 Alternative SW 4 Cost

The cost estimate for this alternative is presented in the attached **Table 4.5-3** and includes the following major components:

- Pre-design and design
- Installation of extraction wells
- Installation of conveyance piping
- Treatment of extracted groundwater
- O&M of the groundwater extraction system
- Monitoring
- Five-year reviews

Note, costs associated with the construction and maintenance of treatment system are included in the cost table for the groundwater hot spot alternative, as presented in the IAFS Report. The estimated time to complete the on-site remedial activities associated with this alternative is approximately three months, and the overall duration of this remedy (including predesign, design, monitoring, and reporting) is estimated to be approximately 30 years. However, evaluation of long-term monitoring data may indicate attainment of RAOs in a timeframe shorter than 30 years. Remedy optimization, such as modifying the number of extraction wells, adjusting the extraction pumping rates, and/or changes to the monitoring program, would be evaluated as part of the annual monitoring report and the five-year review process.

The cost estimate for this alternative, presented in the attached **Table 4.5-3**, is summarized as follows:

Alternative SW 4: Targeted Groundwater Extraction and Treatment	
Capital Cost	$1,574,000
O&M Cost	$5,139,000
Total Cost	$6,713,000
Net Present Worth	$5,017,000
Overall Alternative Duration	30 years

4.5.4 Alternative SW 5: PRBs

This alternative consists of installation of permeable reactive barriers (PRBs) along the length of South Ditch and along the west side of East Ditch from just south of Plant B downstream to just south of the confluence with South Ditch and the Ephemeral Drainage. The proposed PRB locations and associated sheet pile walls are shown on **Figure 4.5-4**. Although the current design for this alternative does not include PRB installation adjacent to the off-PWD, if pre-design investigation and sampling indicate that groundwater impacted with benzo(a)pyrene emanating from the Property is impacting the off-PWD, PRBs will be extended to address these impacts. Discharge from the LNAPL treatment area will be evaluated and contained via the LNAPL alternative selected during the FS process, as presented in the IAFS Report.

The estimated time to complete construction of the PRBs and sheet pile walls is approximately four months. It is assumed that the PRBs are a permanent feature and the associated monitoring would continue for 30 years. However, evaluation of long-term monitoring data may indicate attainment of RAOs in a timeframe shorter than 30 years. Remedy optimization, such as changes to the monitoring program, would be evaluated as part of the annual monitoring report and the five-year review process.

This alternative would consist of the following components:

- Pre-design investigations and design
- Installation of PRBs:
- PRB maintenance and replacement
- Monitoring
- Five-year reviews

<u>Overall Estimated Duration for the Alternative</u>

The overall project duration is estimated to take approximately five years, summarized as follows:

- Pre-design and design — 6 months
- On-site remedial activities — 4 months
- Monitoring — 30 years

Pre-design and design

Pre-design activities would include bench scale testing to verify the effectiveness of the reactive media to be used, and geotechnical investigations to verify the location of the PRBs. Pre-design activities would include evaluation of groundwater flow along East Ditch, South Ditch and if necessary, the off-PWD, to determine the target permeability and thickness of the PRBs, as well as to confirm the southern extent of the PRBs needed to address the headwaters of South Ditch. Note, this section of the PRBs may need to be expanded to address groundwater flow from the west and discharge of groundwater into the off-PWD. Consideration of groundwater chemistry and potential contribution of COCs to surface water would be included as part of the pre-design investigation. The pre-design investigation results would be used to develop the remedial design for the PRBs.

Installation of PRB

Figure 4.5-4 shows the proposed locations of the PRBs. One PRB would be installed along the length of South Ditch. A second PRB would be installed along East Ditch, from the southern edge of the LNAPL treatment area associated with Plant B (refer to the IAFS for LNAPL remedial alternatives). As noted above, if applicable, PRBs would be extended to address discharge of potentially benzo(a)pyrene impacted groundwater into the off-PWD. PRBs would be installed via continuous trenching method, with the PRBs extending from just below the ground surface to weathered bedrock (approximate average depths of 8 feet and 16 feet below ground surface. Two grouted sheet pile walls would be installed at the upstream and downstream ends of South Ditch, to help direct groundwater flow through the PRBs. The grouted sheet pile wall locations are shown on **Figure 4.5-4**. Reactive media for the PRBs would be verified via bench testing during remedial design. For costing purposes, a 50/50 mix of zeolite (for ammonia) and activated carbon (for chromium) has been assumed as the reactive media.

The soil excavated for installation of the PRB sections would be characterized for off-site disposal or for placement under the Containment Area cap. For cost estimating purposes, the excavated soil is assumed to be transported off-site as non-hazardous waste.

PRB maintenance and replacement

Replacement of the PRB media has been assumed to be conducted every 20 years; however, the actual timeframe for media replacement would be further evaluated during treatability testing performed during pre-design activities.

Monitoring

Monitoring associated with this alternative would include semi-annual monitoring of 7 surface water and 12 groundwater monitoring locations as shown on **Figure 4.5-4**. All groundwater and surface water samples would be analyzed for ammonia, NDMA, sulfate, TMPs, BEHP, PAHs, and metals (i.e., aluminum, chromium, iron, lead, and zinc). This monitoring program is assumed to continue for 30 years. However, evaluation of long-term monitoring data may indicate attainment of RAOs in a timeframe shorter than 30 years. Remedy optimization, such as changes to the monitoring program, would be evaluated as part of the annual monitoring report and the five-year review process.

Five-year site review

CERCLA requires that any remedial action that results in contaminants remaining on-site at concentrations above those allowing for unlimited exposure and unrestricted use must be reviewed at least every five years. During five-year site reviews, an assessment is made as to whether the implemented remedy continues to be protective of human health and the environment, or whether the implementation of additional remedial action is appropriate. The USEPA document Comprehensive Five-Year Review Guidance (USEPA, 2001) provides guidance on the performance of five-year reviews. Remedy optimization, such as changes to the monitoring program, would be evaluated as part of the annual monitoring report and the five-year review process.

4.5.4.1 Alternative SW 5 Overall Protection of Human Health and the Environment

This alternative is protective of human health and the environment. Alternative SW-5 would treat the groundwater containing COCs via the PRB prior to its reaching surface water; therefore, it would prevent exposure of current and future human and ecological receptors to surface water containing Site COCs that would result in potential adverse impacts.

4.5.4.2 Alternative SW 5 Compliance with ARARs

The location- and action-specific ARARs that are applicable to the surface water alternatives are identified in **Tables 2.1-10 through 2.1-11**. The applicability of the individual ARARs with respect to this alternative, and how the alternative will comply with the ARAR is identified in these tables.

This alternative would be designed and implemented to minimize potential impacts to nearby wetland areas. Restoration activities for any areas that may be impacted would be implemented to comply with location-specific ARARs identified in **Table 2.1-10**, such as compensatory wetlands mitigation, if necessary, to comply with Clean Water Act Section 404 and the Massachusetts Wetland Protection Act, which have been identified as applicable location-specific requirements.

This alternative would be designed and implemented to comply with the action-specific ARARs identified in **Table 2.1-11** of the OU1/OU2 FS, including but not limited to, hazardous waste regulations related to soil characterization and disposal, NPDES, and Clean Water Act (CWA) Toxic Pollutant Effluent Standards. Soil excavated for installation of the PRB sections, as well as spent PRB media, would be characterized to determine whether these materials would require disposal as hazardous or non-hazardous waste, or could be placed on-site. PRBs would also treat groundwater to protective levels prior to discharging into the streams. As presented in **Table 2.1-11** of the OU1/OU2 FS, the National Recommended Water Quality Criteria (NRWQC) were considered during development of site-specific PRGs for COCs in surface water. In addition, for the off-PWD, human health risk assessment TBCs were considered during development of the site-specific PRGs for COCs in surface water. These site-specific PRGs will be used to monitor surface water to ensure that the PRBs are successful in reducing contaminant levels in surface water to be protective of ecological receptors.

4.5.4.3 Alternative SW 5 Long-term Effectiveness and Permanence

This alternative is effective at mitigating risk to human health and the environment in the long-term. Treatment via the PRBs permanently removes Site COCs from groundwater and prevents their reaching surface water. Thirty years of sampling would be performed to verify achievement of PRGs and long-term protection of human health and the environment. Once Site COCs in groundwater meet PRGs, no residual unacceptable risk to human health and the environment would remain from groundwater or surface water in East Ditch, South Ditch and Off-PWD.

Reactive media may require replacement if media becomes spent, clogged, or blinded. Media replacement has been assumed to be conducted every 20 years for costing purposes. Potential for media replacement would be further evaluated during treatability testing performed during the remedial design phase. Semi-annual sampling would monitor the effectiveness of the media and the need for replacement.

Completion of the remedy from pre-design investigations through construction and long-term O&M, is estimated to take approximately 30 years. However, evaluation of long-term monitoring data may indicate attainment of RAOs in a timeframe shorter than 30 years. Remedy optimization, such as changes to the monitoring program, would be evaluated as part of the annual monitoring report and the five-year review process.

4.5.4.4 Alternative SW 5 Reduction of Toxicity, Mobility, or Volume through Treatment

This alternative would involve in-situ treatment of groundwater and would reduce the toxicity, mobility, and volume of Site COCs in groundwater. In-situ treatment media volumes and ratios would be determined during remedial design; for the purpose of alternative evaluation, a mix of zeolite (for ammonia) and activated carbon (for chromium) has been assumed as the reactive media. Treatment would be irreversible, and treated water would continue its migration past the PRBs with a portion of it discharging into East Ditch and South Ditch. Over time, COCs in surface water will be expected to diminish in concentrations below PRGs such that no unacceptable risks to human health and the environment will remain with respect to the groundwater sources to surface water. This alternative satisfies the statutory preference for treatment as a principal element.

An assessment of mass flux for the primary COCs (i.e., chromium and ammonia) was conducted by dividing each of the PRB walls into sections, establishing flow nets for each section based on interpreted groundwater contours, and calculating the hydraulic gradient. This information along with the cross-sectional area of each PRB section and an average estimated Site-specific hydraulic conductivity of 20 feet per day (ft/day) were then used to calculate the estimated mass flux.

The mass flux for chromium and ammonia, are summarized as follows:

<u>South Ditch</u>

- Estimated chromium mass flux is approximately 0.001 pounds per day (lbs/day)
- Estimated ammonia mass flux is approximately 3 lbs/day

<u>East Ditch</u>

- Estimated chromium mass flux is approximately 0.001 lbs/day
- Estimated ammonia mass flux is approximately 4 lbs/day

As noted above, because of the limited amount of data available, mass flux calculations were not completed for benzo(a)pyrene.

4.5.4.5 Alternative SW 5 Short-term Effectiveness

This alternative is effective at mitigating risk to human health and the environment in the short-term. In-situ treatment would begin as soon as the PRB installation is complete. PRB construction is expected to take four months, and remedy operation and monitoring is expected to take 30 years. During the four-month timeframe of remedy implementation, potential short-term risks to the community would be addressed by minimizing dust, implementing an air monitoring program, decontaminating vehicles transporting excavated soil prior to leaving the Site, and minimizing vehicular traffic associated with the remediation effort traveling through residential areas. Potential short-term risks to Site workers during remedy construction would be addressed through development of a site-specific Health and Safety Plan that adheres to OSHA requirements, including appropriate PPE and air monitoring plans.

Short-term risks to the community during the duration of the remedy's operation would be low. Institutional controls such as fencing and signs would prevent unauthorized or accidental entry to the monitoring areas. Short-term risks during the duration of the remedy's operation would include risks to on-site workers, which would be addressed via a site-specific Health and Safety Plan that adheres to OSHA requirements, including appropriate PPE and air monitoring plans.

Completion of the remedy from pre-design through long-term monitoring, is estimated to take approximately 30 years.

4.5.4.6 Alternative SW 5 Implementability

The major components of this alternative are installation of PRBs and grouted sheet pile walls and groundwater/surface water monitoring. The alternative would use standard construction equipment, and the equipment, materials, and disposal facility for IDW and excavated soil for the PRBs are readily available.

Pre-design activities would include bench testing to verify the effectiveness and volume/ratio of reactive media as well as geotechnical investigations to verify the depth to bedrock and path of the PRBs. No right-of-way or other infrastructure concerns are present in the proposed PRB installation area.

Semi-annual groundwater and surface water sampling is proposed to monitor the effectiveness of the remedy and to identify if and or when media replacement is necessary.

4.5.4.7 Alternative SW 5 Cost

The cost estimate for this alternative is presented in the attached **Table 4.5-4** and includes the following major components:

- Pre-design investigations and design
- Installation of PRBs
- PRB maintenance and replacement
- Monitoring
- Five-year reviews

The estimated time to complete the on-site remedial activities associated with this alternative is approximately four months, and the overall duration of this remedy (including predesign, design, PRB installation, and monitoring) is estimated to be approximately 30 years. However, evaluation of long-term monitoring data may indicate attainment of RAOs in a timeframe shorter than 30 years. Remedy optimization, such as changes to the monitoring program, would be evaluated as part of the annual monitoring report and the five-year review process.

The cost estimate for this alternative, presented in the attached **Table 4.5-4**, is summarized as follows:

Alternative SW 5: Permeable Reactive Barriers	
Capital Cost	$14,732,000
O&M Cost	$13,281,000
Total Cost	28,013,000
Net Present Worth	$22,526,000
Overall Alternative Duration	30 years

4.5.5 Alternative SW 6: Targeted Approach for PRB Installation

This alternative consists of installation of permeable reactive barrier (PRBs) along portions of South Ditch along with a grouted sheet-pile wall to direct groundwater through the PRBs. The proposed PRB and grouted sheet pile wall locations are shown on **Figure 4.5-5**. Although the current design for this alternative does not include PRB installation adjacent to the off-PWD, if pre-design investigation and sampling indicate that groundwater impacted with benzo(a)pyrene emanating from the Property is impacting the off-PWD, PRBs will be extended to address these impacts.

The estimated time to complete construction of the PRBs and sheet pile walls is approximately two months. It is assumed that the PRBs are a permanent feature and the associated monitoring would continue for 30 years. However, evaluation of long-term monitoring data may indicate attainment of RAOs in a timeframe shorter than 30 years. Remedy optimization, such as changes to the monitoring program, would be evaluated as part of the annual monitoring report and the five-year review process. Short-term continued operation of Plant B is assumed for this alternative. If Plant B were to be shut down in the future, an evaluation of Site hydrogeology would be performed first.

This alternative would consist of the following components:

- Pre-design investigations and design
- Installation of PRBs:
- PRB maintenance and replacement
- Monitoring
- Five-year reviews

<u>Overall Estimated Duration for the Alternative</u>

The overall project duration is estimated to take approximately five years, summarized as follows:

• Remedial design	6 months
• On-site remedial activities	2 months
• Monitoring	30 years

Pre-Design and Design

Pre-design investigations would include bench scale testing to verify the effectiveness of the reactive media to be used, and geotechnical investigations to verify the location of the PRBs. Pre-design activities would include evaluation of groundwater flow along South Ditch, and if necessary, the off-PWD to determine the target permeability and thickness of the PRBs, as well as to confirm the extent of the PRBs needed to address the headwaters of South Ditch and the off-PWD. Note, this section of the PRB may need to be expanded to address groundwater flow from the west and discharge of potentially impacted groundwater into the off-PWD. Consideration of groundwater chemistry and potential contribution of COCs to East, South and Off-Property West Ditches would be included as part of the pre-design investigation. The pre-design investigation results would be used to develop the remedial design for the PRBs.

Installation of PRB

Figure 4.5-5 shows the proposed locations of the PRBs and grouted sheet pile walls. One PRB would be installed from the southwest corner of the containment area towards the weir at the upstream end of South Ditch. A grouted sheet pile wall is proposed to be installed perpendicular to the PRB to help direct groundwater flow through the PRB. A second PRB would be installed further downstream along South Ditch, to treat groundwater moving southeast from the containment area towards South Ditch. As noted above, if applicable, PRBs would be extended to address discharge of potentially benzo(a)pyrene impacted groundwater into the off-PWD. PRBs would be installed via continuous trenching method, with the PRB extending from just below the ground surface to weathered bedrock (approximate average depth of 8 feet below ground surface). Reactive media for the PRBs would be verified via bench testing during remedial design. For costing purposes, a 50/50 mix of zeolite (for ammonia) and activated carbon (for chromium) has been assumed as the reactive media.

The soil excavated for installation of the PRB sections would be characterized for off-site disposal or for placement under the containment area cap. For cost estimating purposes, the excavated soil is assumed to be transported off-site as non-hazardous waste.

PRB maintenance and replacement

Replacement of the PRB media has been assumed to be conducted every 20 years; however, the actual timeframe for media replacement would be further evaluated during treatability testing performed during pre-design activities.

Monitoring

Monitoring associated with this alternative would include semi-annual monitoring of 7 surface water and 12 groundwater monitoring locations as shown on **Figure 4.5-5**. All groundwater and surface water samples would be analyzed for ammonia, NDMA, sulfate, TMPs, BEHP, PAHs, and metals (i.e., aluminum, chromium, iron, lead, and zinc). This monitoring program is assumed to continue for 30 years. However, evaluation of long-term monitoring data may indicate attainment of RAOs in a timeframe shorter than 30 years. Remedy optimization, such as changes to the monitoring program, would be evaluated as part of the annual monitoring report and the five-year review process.

Five-year site review

CERCLA requires that any remedial action that results in contaminants remaining on-site at concentrations above those allowing for unlimited exposure and unrestricted use must be reviewed at least every five years. During five-year site reviews, an assessment is made as to whether the implemented remedy continues to be protective of human health and the environment, or whether the implementation of additional remedial action is appropriate. The USEPA document Comprehensive Five-Year Review Guidance (USEPA, 2001) provides guidance on the performance of five-year reviews. Remedy optimization, such as changes to the monitoring program, would be evaluated as part of the annual monitoring report and the five-year review process.

4.5.5.1 Alternative SW 6 Overall Protection of Human Health and the Environment

This alternative is protective of human health and the environment. Alternative SW 6 would treat the groundwater containing COCs via the PRBs prior to its reaching South Ditch and if applicable, the off-PWD; therefore, it would prevent exposure of current and future human and ecological receptors to surface water containing COCs that would result in potential adverse impacts. Short-term continued operation of Plant B is assumed for this alternative. If Plant B were to be shut down in the future, an evaluation of Site hydrogeology would be performed first to ensure continued protection of human health and the environment.

4.5.5.2 Alternative SW 6 Compliance with ARARs

The location- and action-specific ARARs that are applicable to the surface water alternatives are identified in **Tables 2.1-10 through 2.1-11**. The applicability of the individual ARARs with respect to this alternative, and how the alternative will comply with the ARAR is identified in these tables.

This alternative would be designed and implemented to minimize potential impacts to nearby wetland areas. Restoration activities for any areas that may be impacted would be implemented to comply with location-specific ARARs identified in **Table 2.1-10**, such as compensatory wetlands mitigation, if necessary, to comply with Clean Water Act Section 404 and the Massachusetts Wetland Protection Act, which have been identified as applicable location-specific requirements.

This alternative would be designed and implemented to comply with the action-specific ARARs identified in **Table 2.1-11** of the OU1/OU2 FS, including but not limited to, hazardous waste regulations related to soil characterization and disposal, NPDES, and Clean Water Act (CWA) Toxic Pollutant Effluent Standards. Soil excavated for installation of the PRB sections, as well as spent PRB media, would be characterized to determine whether these materials would require disposal as hazardous or non-hazardous waste, or could be placed on-site. PRBs would also treat groundwater to protective levels prior to discharging into the streams. As presented in **Table 2.1-11** of the OU1/OU2 FS, the National Recommended Water Quality Criteria (NRWQC) were considered during development of site-specific PRGs for COCs in surface water. In addition, for the off-PWD, human health risk assessment TBCs were considered during development of the site-specific PRGs for COCs in surface water. These site-specific PRGs will be used to monitor surface water to ensure that the PRBs are successful in reducing contaminant levels in surface water to be protective of ecological receptors.

4.5.5.3 Alternative SW 6 Long-term Effectiveness and Permanence

This alternative is effective at mitigating risk to human health and the environment in the long-term. Treatment via the PRB permanently removes Site COCs from groundwater and prevents discharge to South Ditch and if applicable, the off-PWD. Thirty years of sampling would be performed to verify achievement of PRGs and long-term protection of human health and the environment. Once Site COCs in groundwater meet PRGs, no residual unacceptable risk to human health and the environment will remain from groundwater or surface water in East Ditch, South Ditch, and the off-PWD.

Reactive media may require replacement if media becomes spent, clogged, or blinded. Media replacement has been assumed to be conducted every 20 years for costing purposes. Potential for media replacement would be further evaluated during treatability testing performed during the remedial design phase. Semi-annual sampling would monitor the effectiveness of the media and the need for replacement.

Completion of the remedy from pre-design investigations through construction and long-term O&M, is estimated to take approximately 30 years. However, evaluation of long-term monitoring data may indicate attainment of RAOs in a timeframe shorter than 30 years. Remedy optimization, such as changes to the monitoring program, would be evaluated as part of the annual monitoring report and the five-year review process.

4.5.5.4 Alternative SW 6 Reduction of Toxicity, Mobility, or Volume through Treatment

This alternative would involve in-situ treatment of groundwater and would reduce the toxicity, mobility, and volume of Site COCs in groundwater. In-situ treatment media volumes and ratios would be determined during remedial design; for the purpose of alternative evaluation, a mix of zeolite (for ammonia) and activated carbon (for chromium) has been assumed as the reactive media. Treatment would be irreversible, and treated water would continue its migration past the PRBs with a portion of it discharging into South Ditch. Over time, COCs in surface water will be expected to diminish in concentrations below PRGs such that no unacceptable risks to human health and the environment will remain with respect to the groundwater sources to surface water. This alternative satisfies the statutory preference for treatment as a principal element.

An assessment of mass flux for the primary COCs (i.e., chromium and ammonia) was conducted by dividing the PRBs into sections, establishing flow nets for each section based on interpreted groundwater contours, and calculating the hydraulic gradient for each section. This information along with the cross-sectional area of each PRB section and an average estimated hydraulic conductivity of 20 ft/day were then used to calculate the estimated mass flux.

The mass flux for chromium and ammonia, are summarized as follows:

<u>South Ditch</u>

- Estimated chromium mass flux is approximately 0.001 pounds per day (lbs/day)
- Estimated ammonia mass flux is approximately 3 lbs/day

As noted above, because of the limited amount of data available, mass flux calculations were not completed for benzo(a)pyrene.

4.5.5.5 Alternative SW 6 Short-term Effectiveness

This alternative is effective at mitigating risk to human health and the environment in the short-term. In-situ treatment would begin as soon as the PRB installation is complete. PRB construction is expected to take two months, and remedy operation and monitoring is expected to take 30 years. During the four-month timeframe of remedy implementation, potential short-term risks to the community would be addressed by minimizing dust, implementing an air monitoring program, decontaminating vehicles transporting excavated soil prior to leaving the Site, and minimizing vehicular traffic associated with the remediation effort traveling through residential areas. Potential short-term risks to Site workers during remedy construction would be addressed through development of a site-specific Health and Safety Plan that adheres to OSHA requirements, including appropriate PPE and air monitoring plans.

Short-term risks to the community during the duration of the remedy's operation would be low. Institutional controls such as fencing and signs would prevent unauthorized or accidental entry to the monitoring areas. Short-term risks during the duration of the remedy's operation would include risks to on-site workers, which would be addressed via a site-specific Health and Safety Plan that adheres to OSHA requirements, including appropriate PPE and air monitoring plans.

Completion of the remedy from pre-design through long-term monitoring, is estimated to take approximately 30 years.

4.5.5.6 Alternative SW 6 Implementability

The major components of this alternative are installation of PRBs and grouted sheet pile walls and groundwater/surface water monitoring. The alternative would use standard construction equipment, and the equipment, materials, and disposal facility for IDW and excavated soil for the PRB are readily available.

Pre-design activities would include bench testing to verify the effectiveness and volume/ratio of reactive media as well as geotechnical investigations to verify the depth to bedrock and path of the PRBs. No right-of-way or other infrastructure concerns are present in the proposed PRB installation area.

Semi-annual groundwater and surface water sampling is proposed to monitor the effectiveness of the remedy and to identify if and or when media replacement is necessary.

4.5.5.7 Alternative SW 6 Cost

The cost estimate for this alternative is presented in the attached **Table 4.5-5** and includes the following major components:

- Pre-design investigations and design
- Installation of PRBs:
- PRB maintenance and replacement
- Monitoring
- Five-year reviews

The estimated time to complete the on-site remedial activities associated with this alternative is approximately two months, and the overall duration of this remedy (including predesign, design, PRB installation, and monitoring) is estimated to be approximately 30 years. However, evaluation of long-term monitoring data may indicate attainment of RAOs in a timeframe shorter than 30 years. Remedy optimization, such as changes to the monitoring program, would be evaluated as part of the annual monitoring report and the five-year review process.

The cost estimate for this alternative, presented in the attached **Table 4.5-5**, is summarized as follows:

Alternative SW 6: Targeted Approach for Permeable Reactive Barriers	
Capital Cost	$3,722,000
O&M Cost	$4,524,000
Total Cost	$8,246,000
Net Present Worth	$6,475,000
Overall Alternative Duration	30 years

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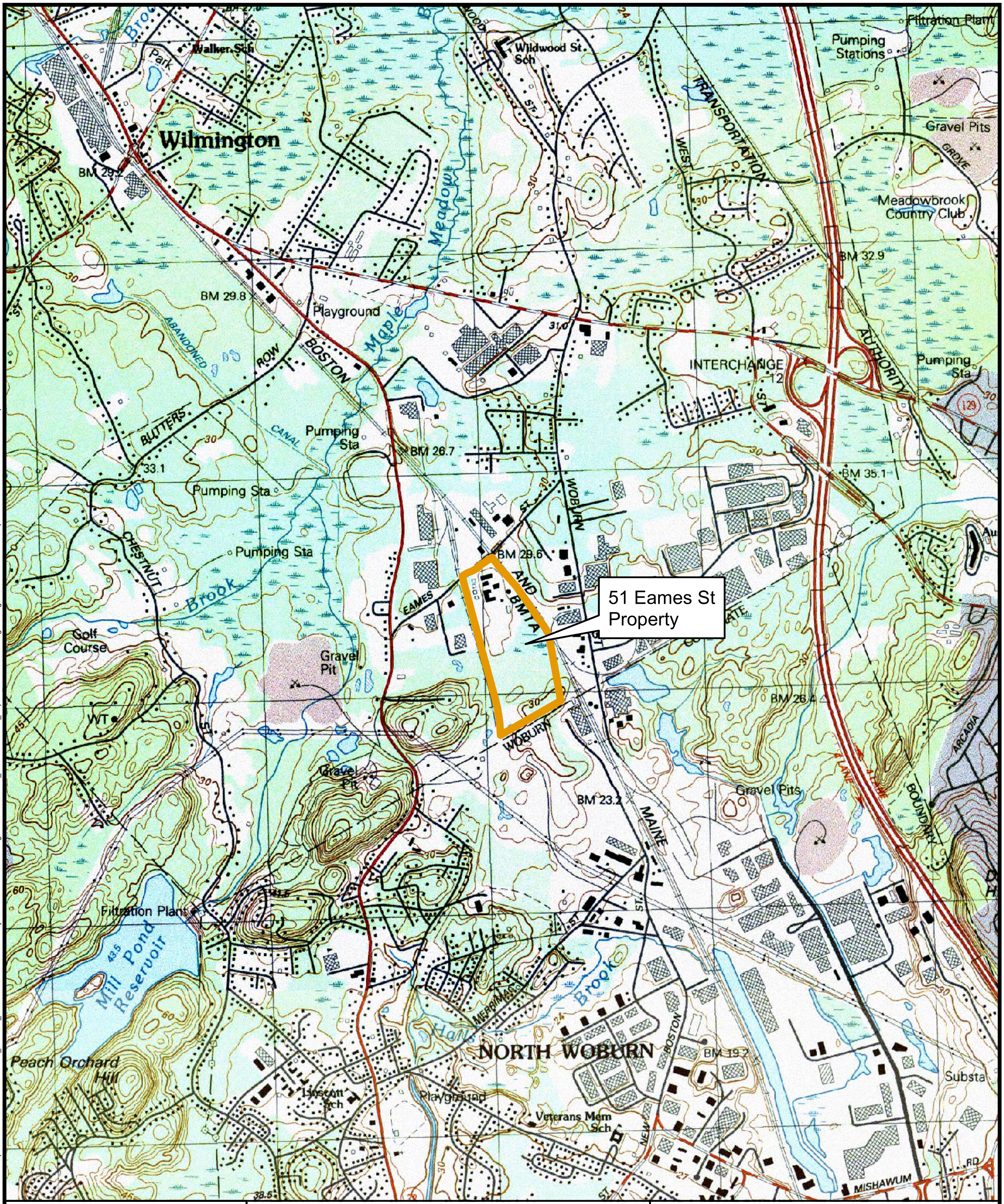
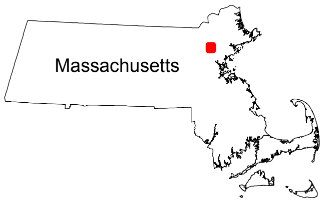
Figures





Wood
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271 Mill Road
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N

0 1,000 2,000 4,000
Feet

Figure 1.2-1
Site Location

OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared/Date: BRP 04/26/19 | Checked/Date: APP 04/26/19

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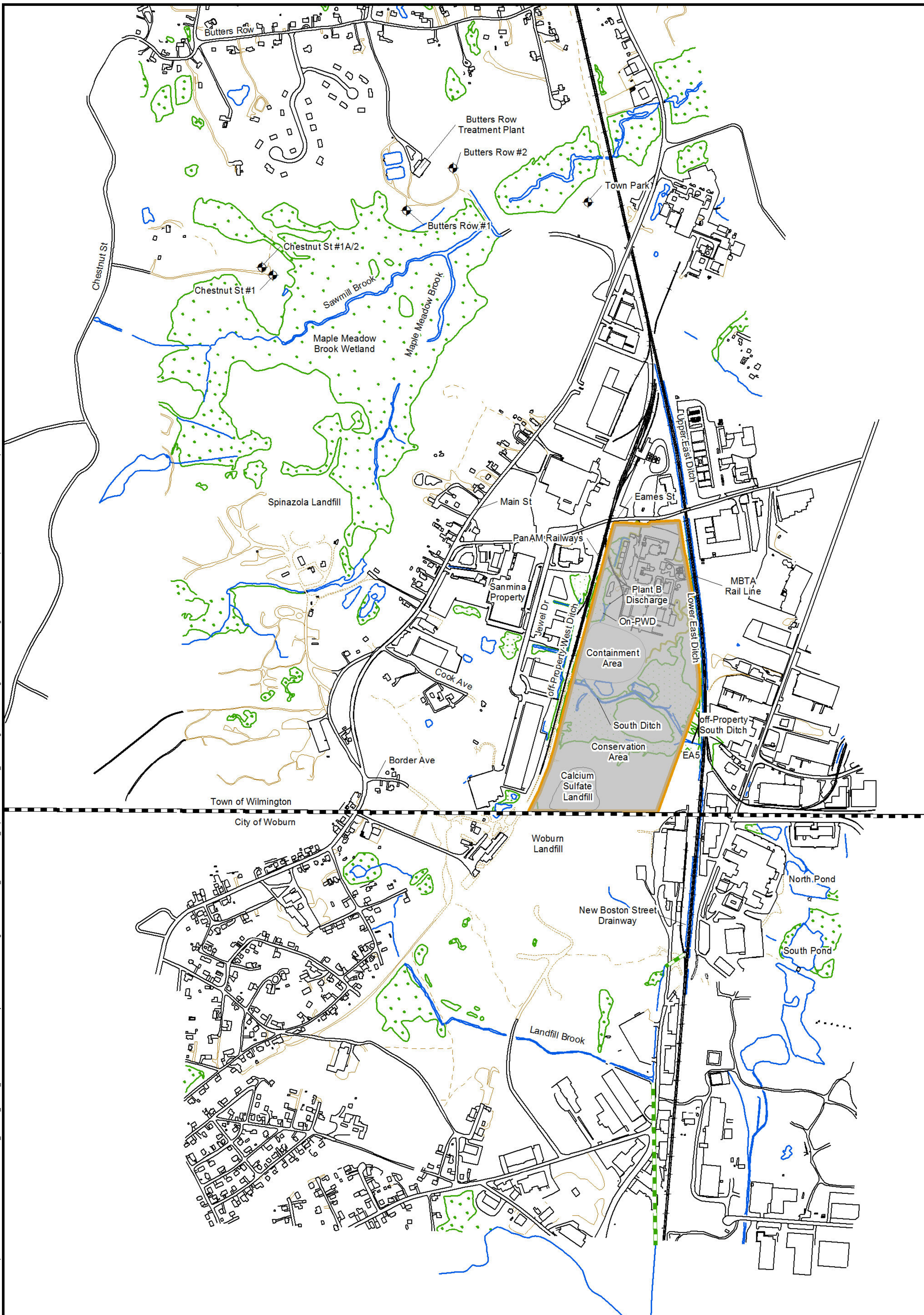

Legend

Operable Unit 1
51 Eames St. Property Boundary
Town Wells
Town Line
Railroad
Paved Road
Unpaved Road
Structure
Surface Water
Trails
Wooded Areas
Wetland Boundary
Culvert

*Operable Unit 2 is portion shown outside of OU1.

wood.

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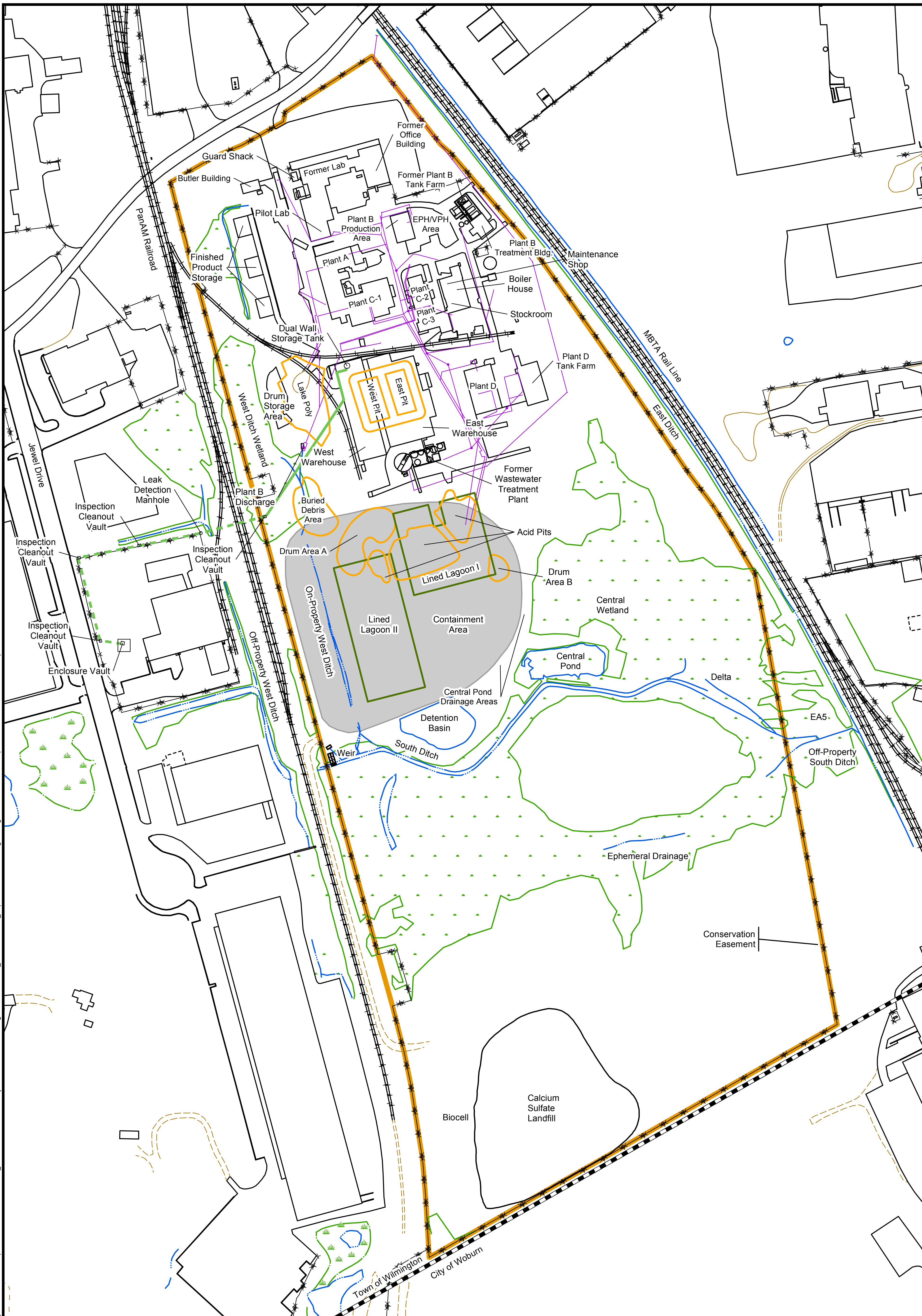
N

0 370 740 1,480
Feet

Figure 1.2-2
Site Features

OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared/Date: BRP 04-17-20 | Checked/Date: JDW 04-17-20



Legend

- 51 Eames St. Property Boundary
- Containment Structure
- Historical Disposal Area
- Aboveground Conveyance Piping
- Underground Conveyance Piping
- Structure
- Paved Road
- Unpaved Road
- Railroad
- Town Line
- Fence
- Trail
- Drain/Sewer Line
- Surface Water
- Wetland Boundary

wood.

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Figure 1.3-1
Site Features (Current and Historic)

OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

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Legend

- Exposure Area
- Culvert
- 51 Eames St. Property Boundary
- Paved Road
- Unpaved Road
- Railroad
- Surface Water
- Wetland Boundary

wood.

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0 250 500
Feet

Figure 1.3-2
HHRA Exposure Areas

OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

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Legend

Exposure Area	Paved Road
Culvert	Unpaved Road
51 Eames St. Property Boundary	Railroad
	Surface Water
	Wetland Boundary

wood.

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N

0 250 500
Feet

Figure 1.3-3
BERA Exposure Areas

OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

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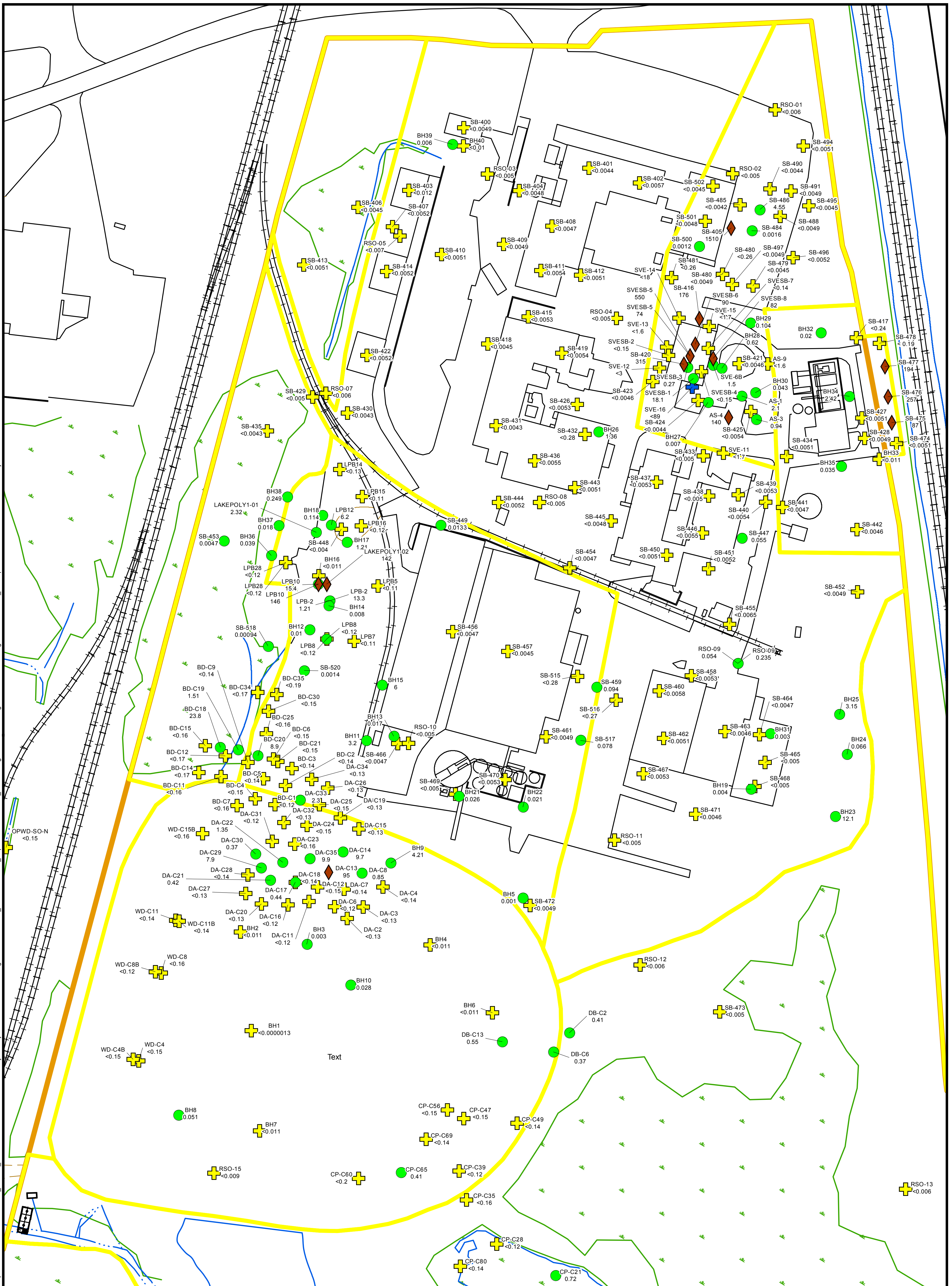

Notes:
1. < - Not Detected, value shown is reporting limit
2. Samples collected as part of the RI have IDs SS-4XX, SB-4XX, SB-5XX, or SB-5XXX. All other samples were collected previous to the RI.

Legend

- Analyte Detected Below 39 mg/kg
- Analyte Detected Above 39 mg/kg
- 2.5 Detected Analyte Concentration (mg/kg)
- Analyte not detected
- 51 Eames St. Property Boundary
- Railroad
- Paved Road
- Unpaved Road
- Sidewalks
- Structure
- Surface Water
- Wetland Boundary

wood.

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N

0 50 100 200
Feet

Figure 1.4-1
Distibution of Trimethylpentenes In Shallow Subsurface Soil

OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared/Date: ICD 03/19/20 | Checked/Date: MM 03/18/20

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Legend

- Analyte Detected Below 39 mg/kg
- Analyte Detected Above 39 mg/kg
- Analyte not detected - Reporting Limit Below Industrial RSL
- 2.5 Detected Analyte Concentration (mg/kg)
- 51 Eames St. Property Boundary
- Exposure Area Boundaries
- Water
- Railroad
- Paved Road
- Unpaved Road
- Wetland Boundary

Notes:
1. < - Not Detected, value shown is reporting limit
2. Samples collected as part of the RI have IDs SS-4XX, SB-4XX, SB-5XX, or SB-5XXX. All other samples were collected previous to the RI.

N

0 50 100 Feet

wood.

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Figure 1.4-2
Distribution of Trimethylpentenes in OU1 Upland Deep Subsurface Soil
OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared/Date: ICD 03/19/20 | Checked/Date: MM 03/19/20

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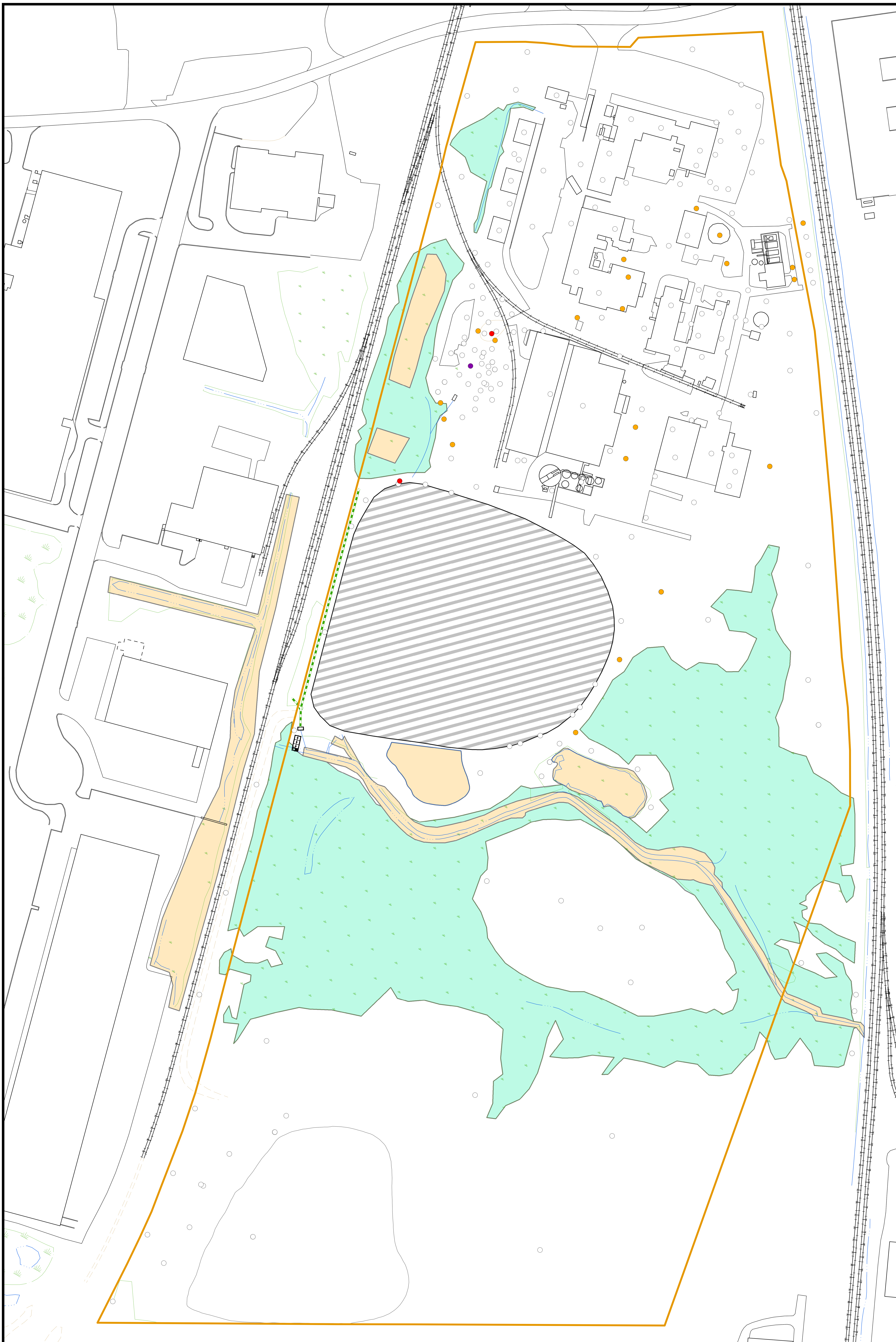

Legend Upland Soils 0-1': ○ Below Both PRGs ● Above BEHP PRG (3 mg/kg) ● Above Chromium PRG (1000 mg/kg) ● Above Both PRGs Containment Area Soil Upland Soil Wetland Soil Considered to be Sediment 51 Eames St. Property Boundary Water Railroad Paved Road Unpaved Road Wetland Boundary	Wood Environment & Infrastructure Solutions 271 Mill Road Chelmsford, MA 01824 N 0 80 160 Feet	**Figure 1.4-3** **Distribution of Chromium and BEHP in OU1/OU2 Upland Surface Soil** **OU1 & OU2 Feasibility Study** **Olin Chemical Superfund Site** **Wilmington, Massachusetts** Prepared/Date: ICD 03/18/20 | Checked/Date: JDW 03/18/20

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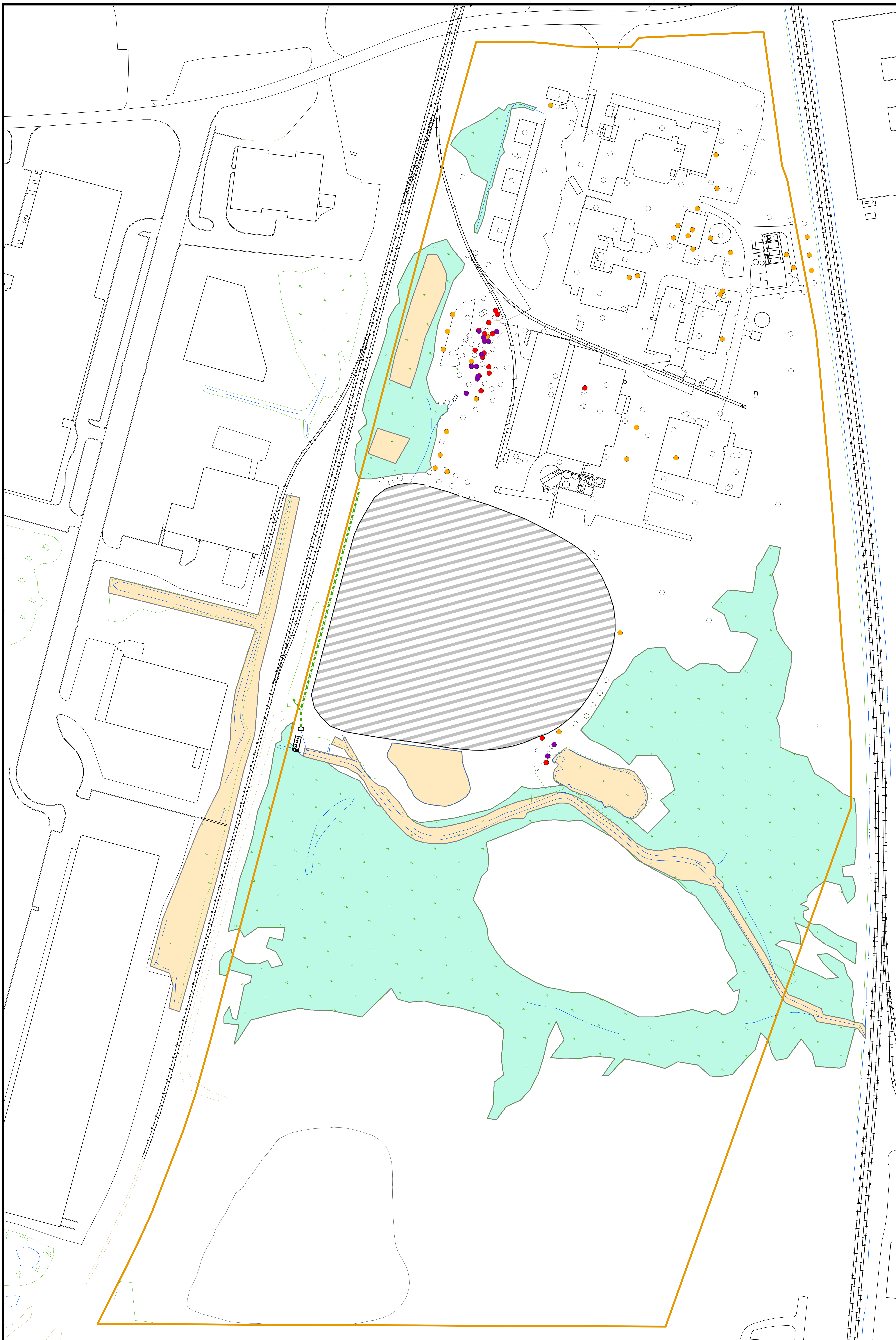

Legend

Upland Soils 1-10':
- Below Both PRGs
- Above BEHP PRG (3 mg/kg)
- Above Chromium PRG (1000 mg/kg)
- Above Both PRGs

- Containment Area Soil
- Upland Soil
- Wetland Soil
- Considered to be Sediment
- 51 Eames St. Property Boundary

- Water
- Railroad
- Paved Road
- Unpaved Road
- Wetland Boundary

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N

0 80 160 Feet

Figure 1.4-4
Distribution of Chromium and BEHP in OU1/OU2 Upland Shallow Subsurface Soil

OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared/Date: ICD 03/18/20	Checked/Date: JDW 03/18/20

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Legend

Sediment & Wetland Soils:
- Below Both PRGs
- Above BEHP PRG
- Above Chromium PRG
- Above Both PRGs

- Containment Area Soil
- Upland Soil
- Wetland Soil
- Considered to be Sediment

- 51 Eames St. Property Boundary
- Water
- Railroad
- Paved Road
- Unpaved Road
- Wetland Boundary

PRGs:	BEHP	Chromium
Wetland Soils:	20 mg/kg	600 mg/kg
Sediment:	100 mg/kg	100 mg/kg

N

0 80 160 Feet

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Figure 1.4-5
Distribution of Chromium and BEHP in OU1/OU2 Wetland Soil and Sediment (0-1 ft)

OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared/Date: ICD 03/18/20 | Checked/Date: MM 03/18/20

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Legend

Wetland Soils 1-10':
- Below Both PRGs
- Above BEHP PRG (20 mg/kg)
- Above Chromium PRG (600 mg/kg)
- Above Both PRGs

- Containment Area Soil
- Upland Soil
- Wetland Soil
- Considered to be Sediment

- 51 Eames St. Property Boundary
- Water
- Railroad
- Paved Road
- Unpaved Road
- Wetland Boundary

PRGs:	BEHP	Chromium
Wetland Soils:	20 mg/kg	600 mg/kg
Sediment:	100 mg/kg	100 mg/kg

N

0 80 160 Feet

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Figure 1.4-6
Distribution of Chromium and BEHP in OU1/OU2 Wetland Soil and Sediment (1-10 ft)

OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

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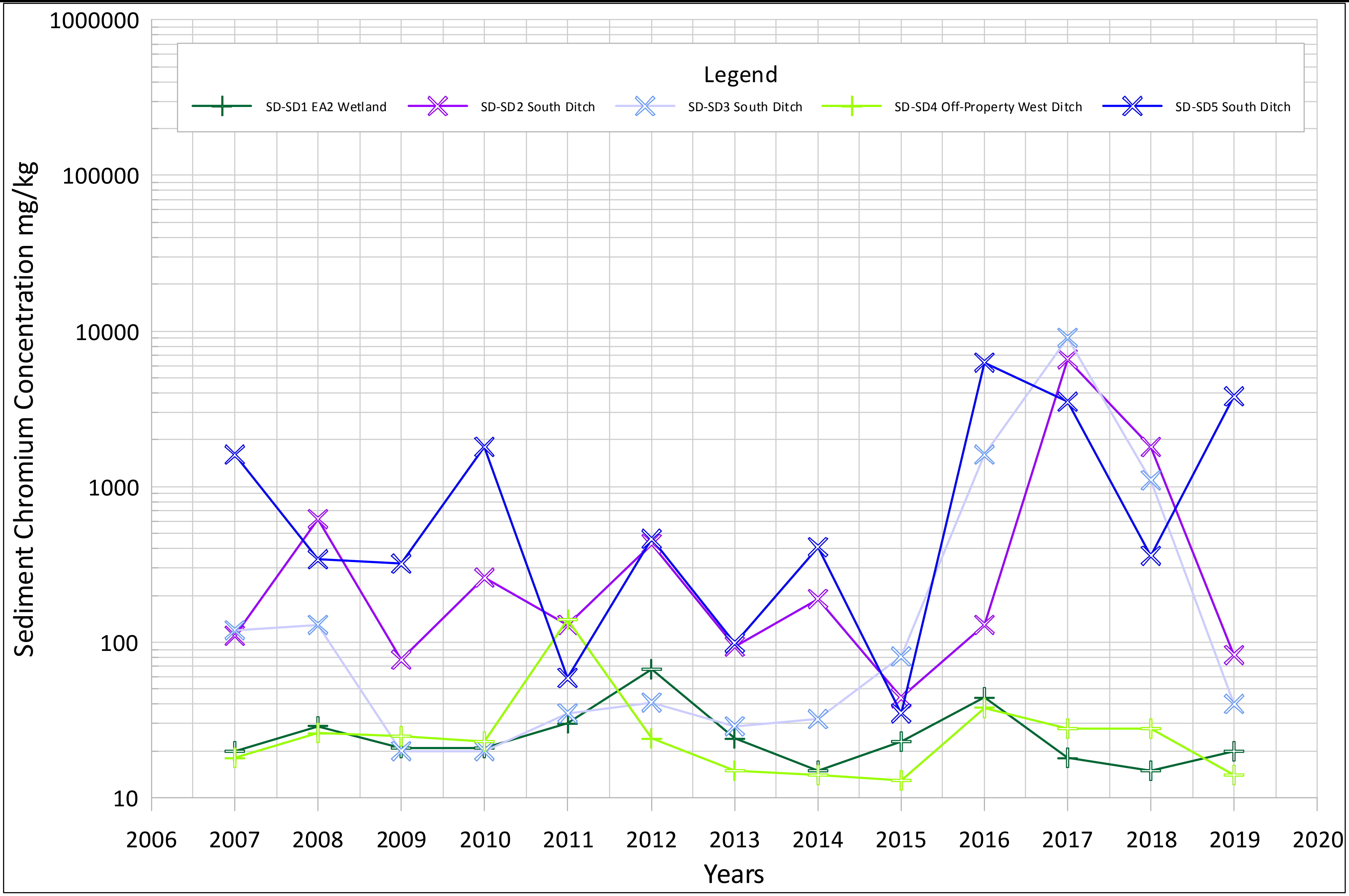

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Figure 1.4-7
Trend Plots
Chromium in Sediments of South Ditch

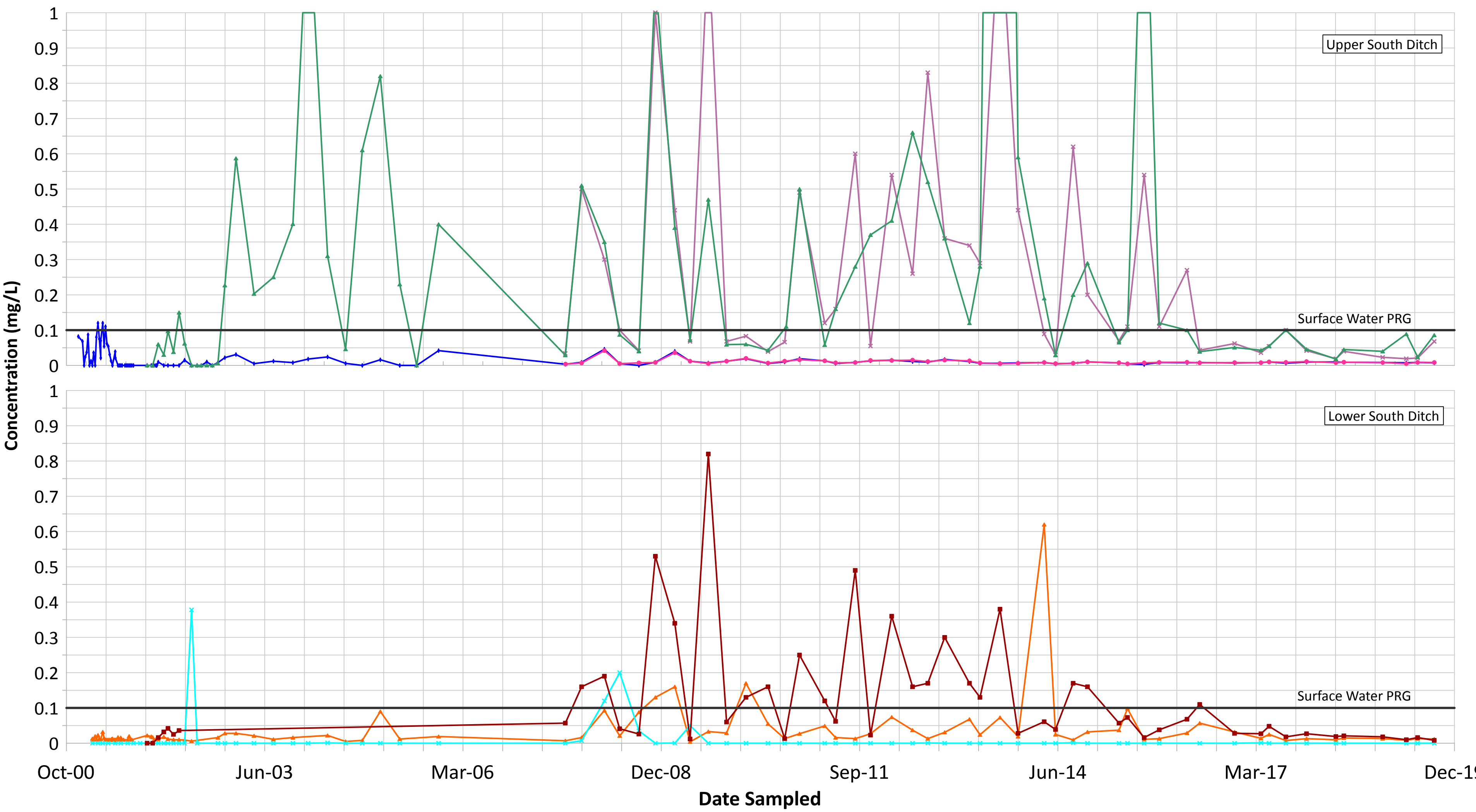
OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

N

0 70 140 280 Feet

Prepared/Date: ICD 03/19/20

Checked/Date: MM 03/19/20



Symbol Key

ISCO1 — PZ-17 RRR SW — PZ-18R SW — SD-17

ISCO2 — ISCO3 — PZ-16RRR — Chromium PRG 0.10 mg/L

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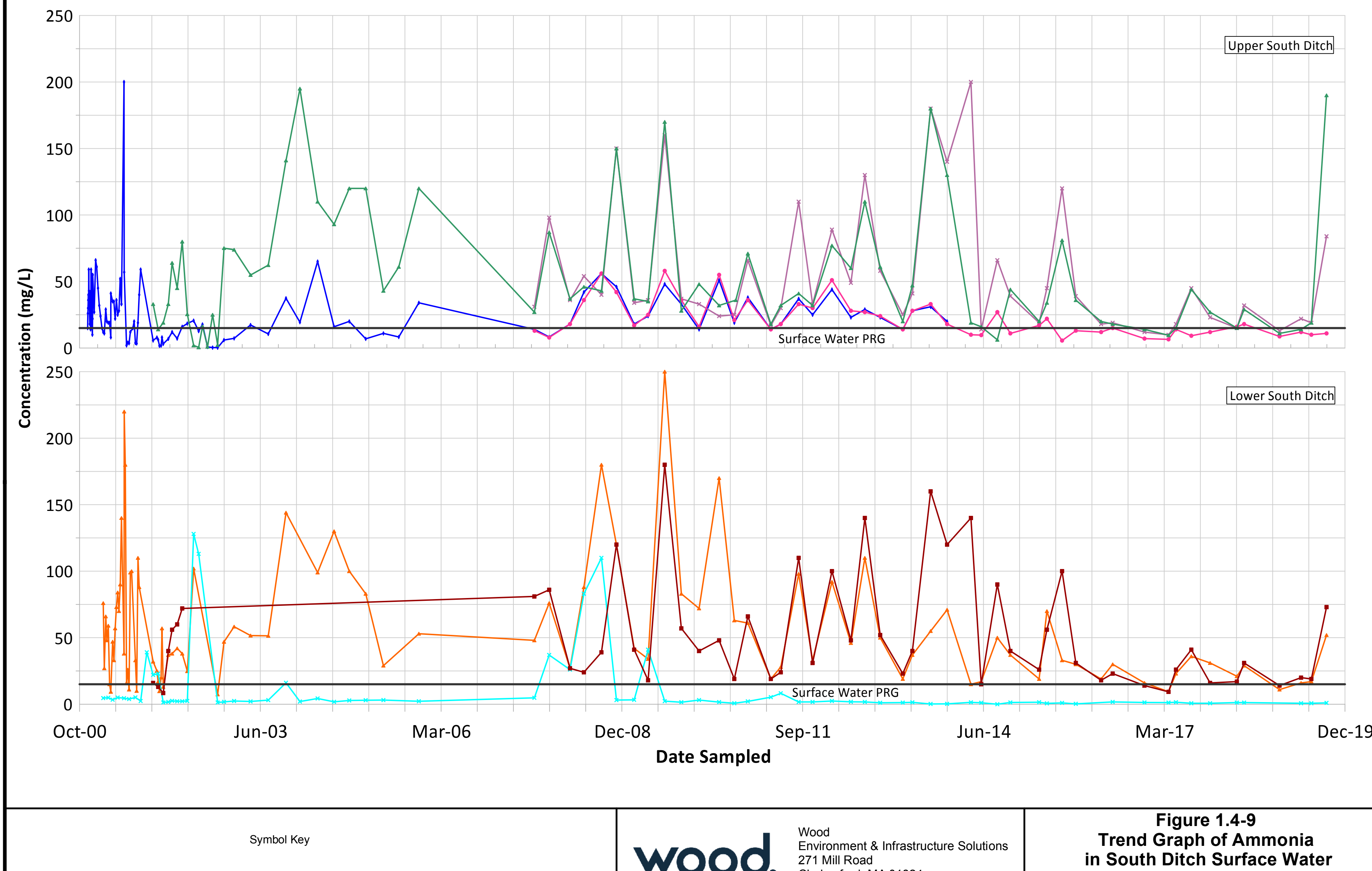
N

0 70 140 280 Feet

Figure 1.4-8
Trend Graph of Dissolved Chromium in South Ditch Surface Water

OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared/Date: ICD 03/31/20 | Checked/Date: MM 03/31/20



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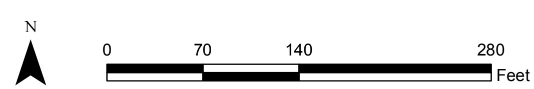
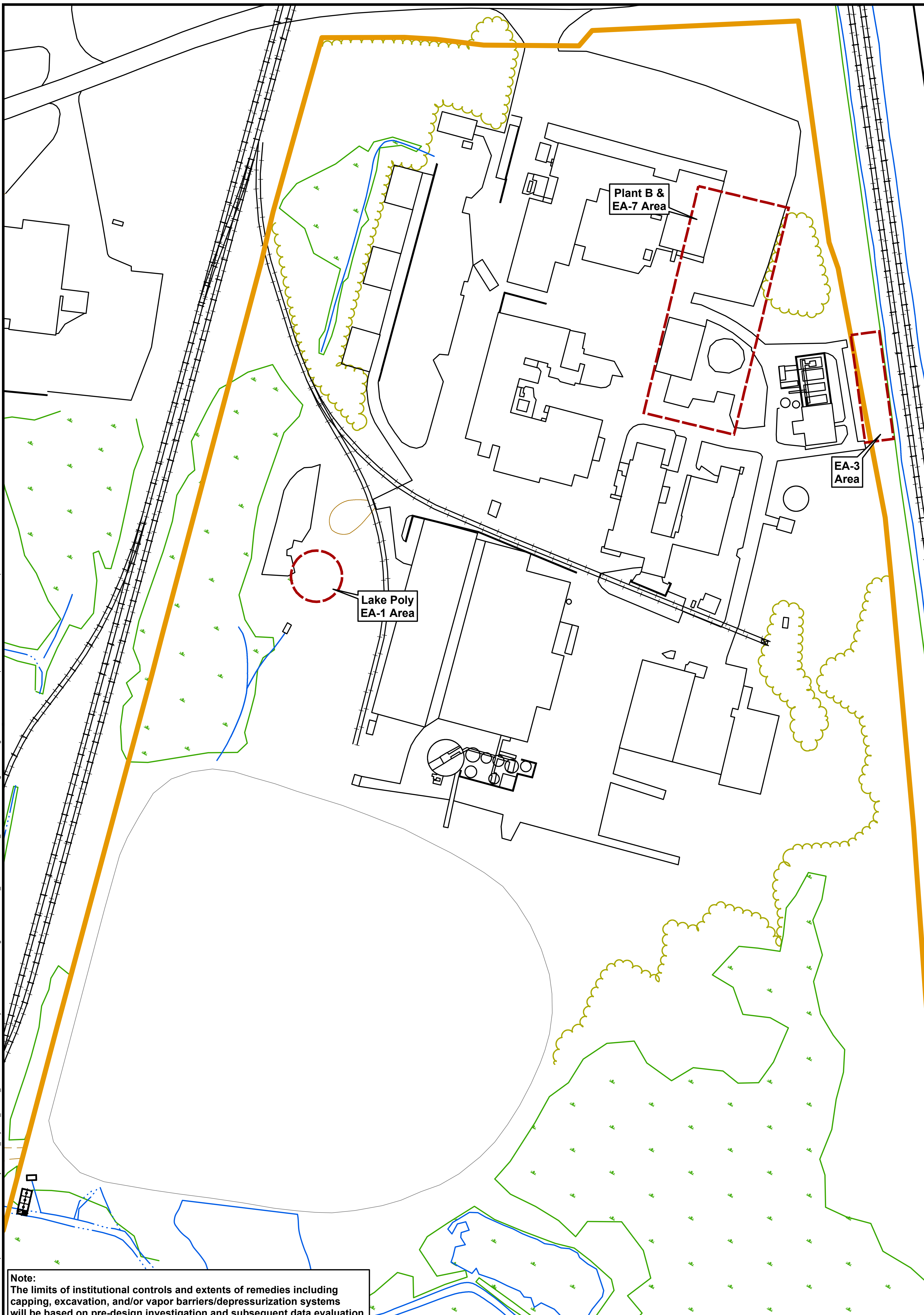


Figure 1.4-9
Trend Graph of Ammonia in South Ditch Surface Water

OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared/Date: ICD 04/01/20 | Checked/Date: MM 04/01/20



Note:
The limits of institutional controls and extents of remedies including capping, excavation, and/or vapor barriers/depressurization systems will be based on pre-design investigation and subsequent data evaluation.

Legend

- TMP Remedial Areas
- 51 Eames St. Property Boundary
- Railroad
- Paved Road
- Unpaved Road
- Sidewalks
- Structure
- Surface Water
- Wooded Areas
- Wetland Boundary

wood.

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N

0 50 100 200
Feet

Figure 2.2-1
Estimated Remediation Areas - TMPs in Soil

OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared/Date: BRP 07/21/20 | Checked/Date: BKH 07/21/20

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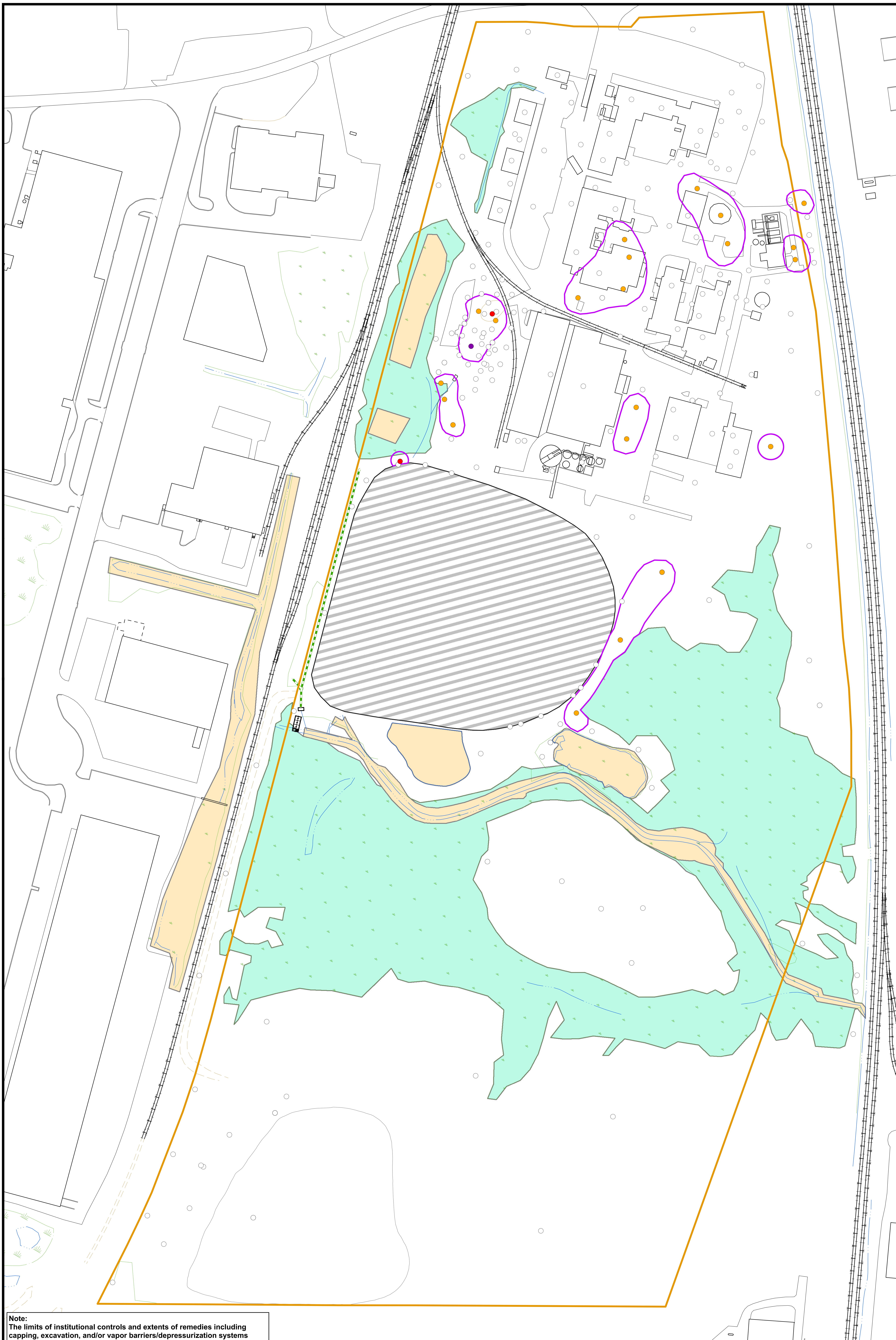

Note:
The limits of institutional controls and extents of remedies including capping, excavation, and/or vapor barriers/depressurization systems will be based on pre-design investigation and subsequent data evaluation.

Legend

Upland Soils 0-1':
- Below Both PRGs
- Above BEHP PRG (3 mg/kg)
- Above Chromium PRG (1000 mg/kg)
- Above Both PRGs
- Estimated Remediation Areas

- Containment Area Soil
- Upland Soil
- Wetland Soil
- Considered to be Sediment

- 51 Eames St. Property Boundary
- Water
- Railroad

- Paved Road
- Unpaved Road
- Wetland Boundary

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N

0 80 160
Feet

Figure 2.2-2
Estimated Remediation Areas in Upland Surface Soil (0-1 ft)

OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

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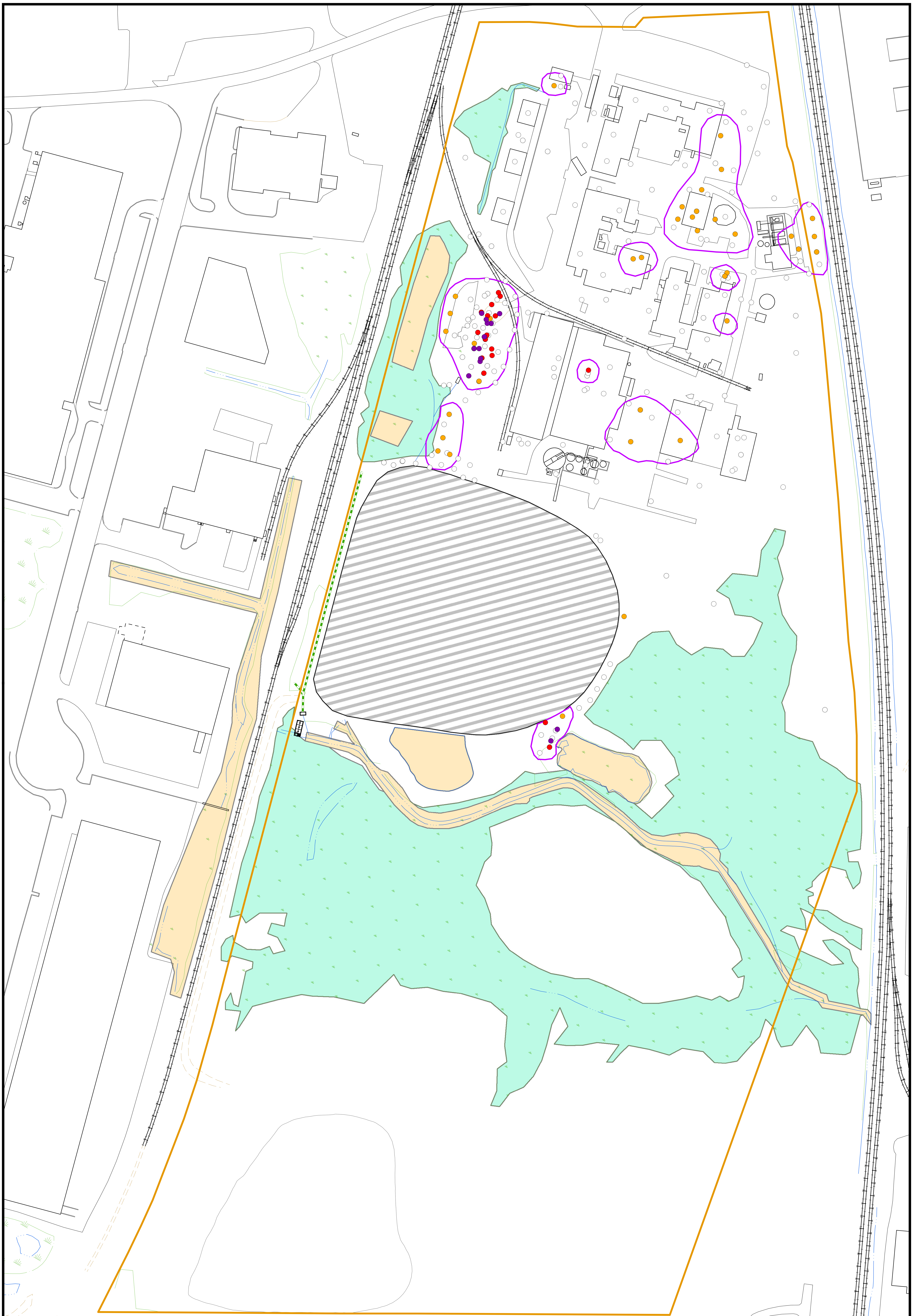

Note:
The limits of institutional controls and extents of remedies including capping, excavation, and/or vapor barriers/depressurization systems will be based on pre-design investigation and subsequent data evaluation.

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Figure 2.2-3
Estimated Remediation Areas in Upland Shallow Subsurface Soil (1-10 ft)

OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

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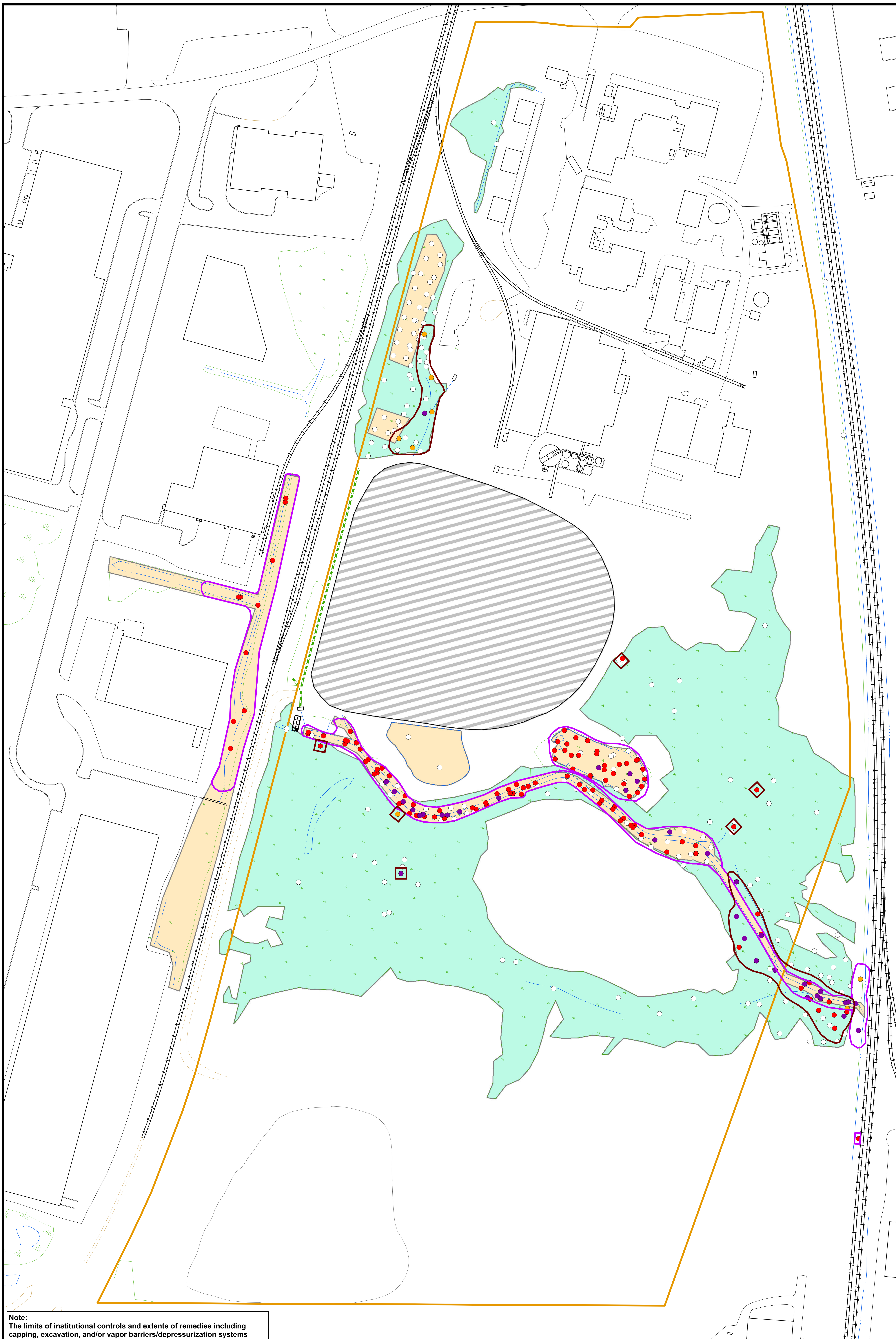

Note:
The limits of institutional controls and extents of remedies including capping, excavation, and/or vapor barriers/depressurization systems will be based on pre-design investigation and subsequent data evaluation.

Legend

Sediment & Wetland Soils:
- Below Both PRGs
- Above BEHP PRG
- Above Chromium PRG
- Above Both PRGs

- Estimated Wetland Excavation Area
- Estimated Sediment Excavation Area
- Containment Area Soil
- Upland Soil
- Wetland Soil
- Considered to be Sediment

- 51 Eames St. Property Boundary
- Water
- Railroad
- Paved Road
- Unpaved Road
- Wetland Boundary

PRGs:	BEHP	Chromium
Wetland Soils:	20 mg/kg	600 mg/kg
Sediment:	100 mg/kg	100 mg/kg

N

0 80 160 Feet

Wood
Environment & Infrastructure Solutions
271 Mill Road
Chelmsford, MA 01824

Figure 2.2-4
Estimated Remediation Areas in Wetland Soil (0-1 ft) and Sediment

OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

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Note:
The limits of institutional controls and extents of remedies including capping, excavation, and/or vapor barriers/depressurization systems will be based on pre-design investigation and subsequent data evaluation.

Legend

Wetland Soils 1-10':
- Below Both PRGs
- Above BEHP PRG (20 mg/kg)
- Above Chromium PRG (600 mg/kg)
- Above Both PRGs
- Estimated Deed Restriction Areas

- Containment Area Soil
- Upland Soil
- Wetland Soil
- Considered to be Sediment

- 51 Eames St. Property Boundary
- Water
- Railroad

- Paved Road
- Unpaved Road
- Wetland Boundary

Wood
Environment & Infrastructure Solutions
271 Mill Road
Chelmsford, MA 01824

N

0 80 160
Feet

Figure 2.2-5
Estimated Remediation Areas in Wetland Soil (1-10 ft) and Sediment

OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

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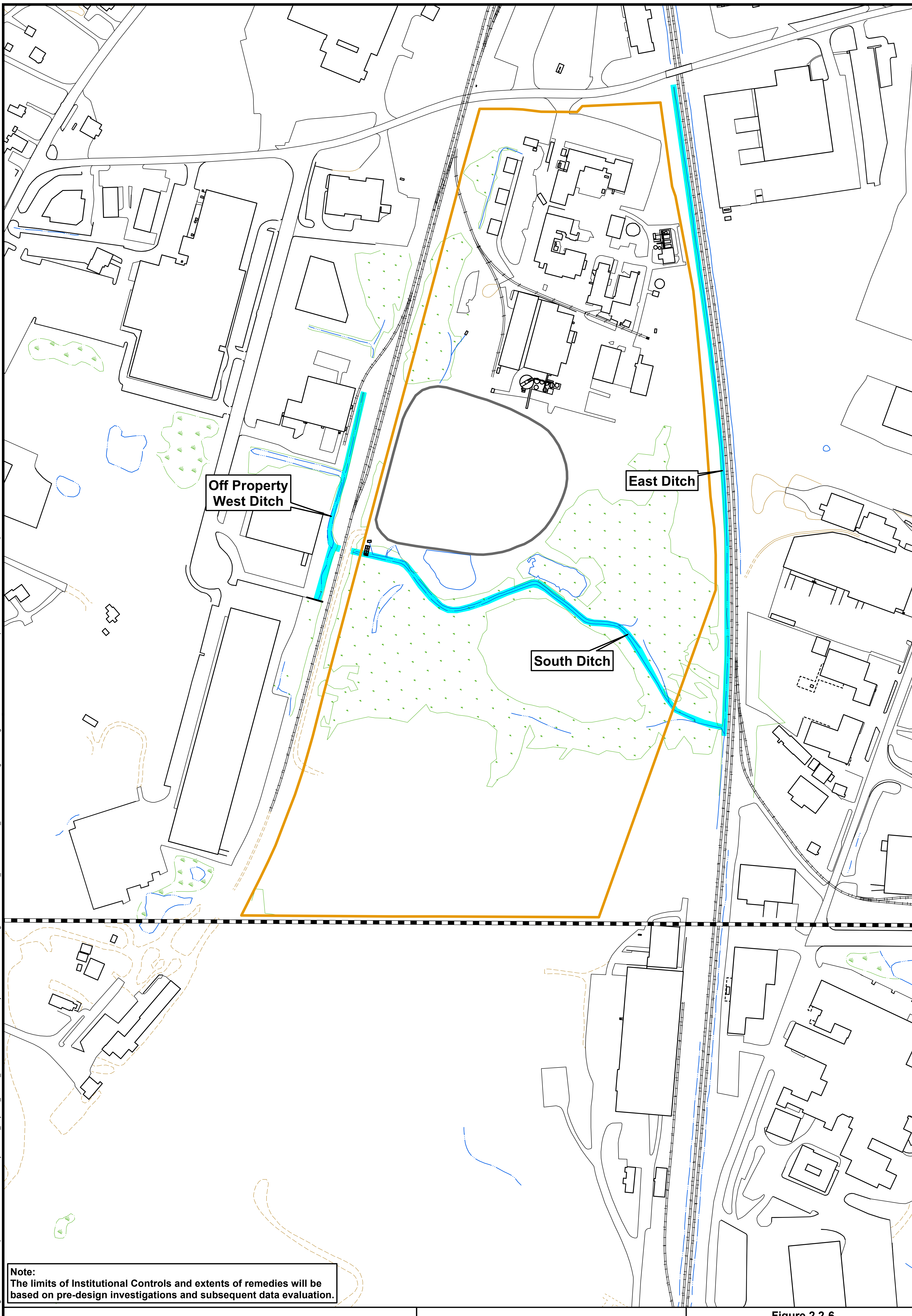

Legend

- Surface Water Areas
- Slurry Wall
- Wilmington/Woburn Town Line
- 51 Eames St. Property Boundary
- Water
- Railroad
- Paved Road
- Unpaved Road
- Wetland Boundary

wood.

Wood
Environment & Infrastructure Solutions
271 Mill Road
Chelmsford, MA 01824

N

0 130 260 520
Feet

Figure 2.2-6
Surface Water Areas to be Addressed by Remedial Alternatives

OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

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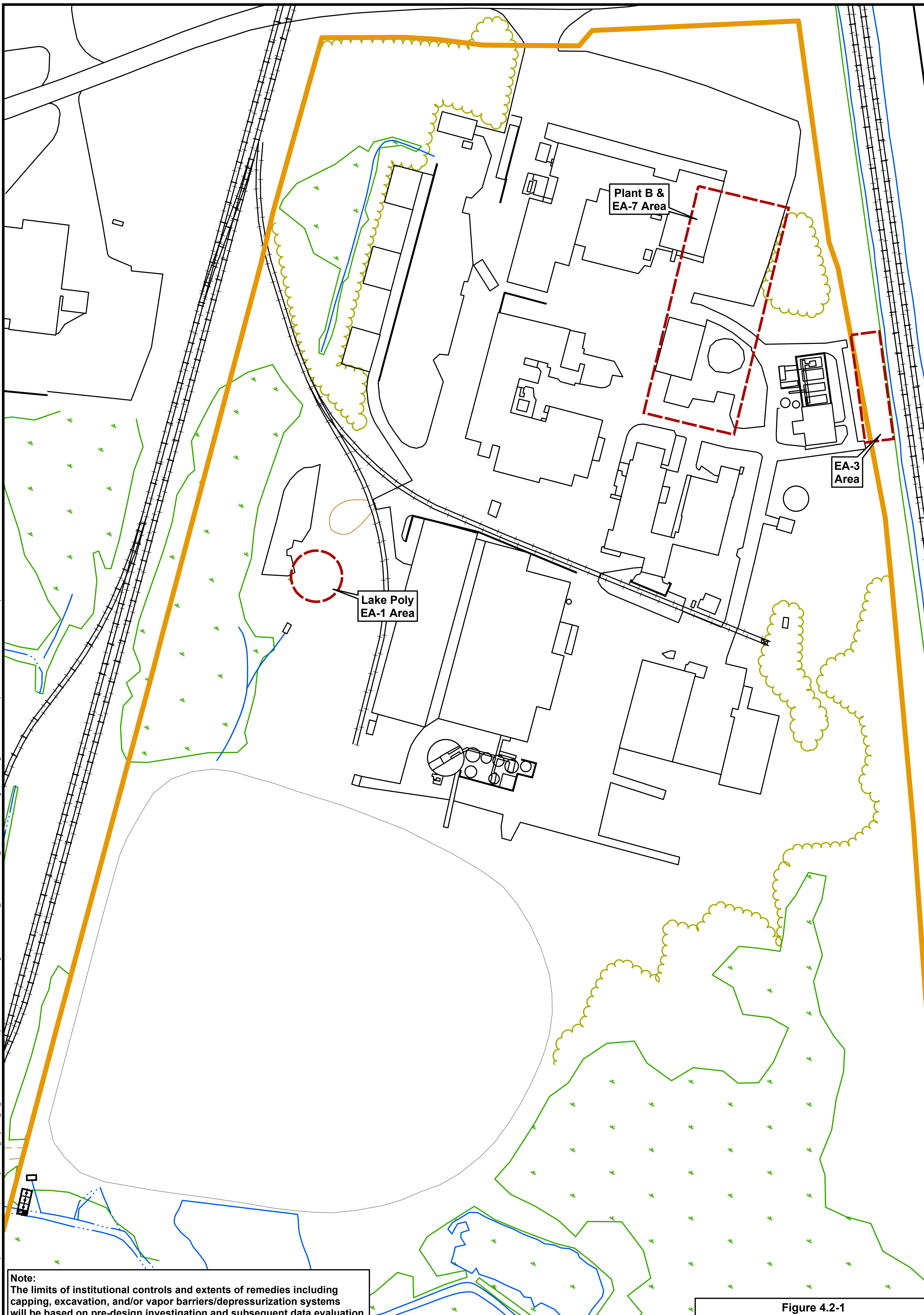

Note:
The limits of institutional controls and extents of remedies including capping, excavation, and/or vapor barriers/depressurization systems will be based on pre-design investigation and subsequent data evaluation.

Legend

TMP Remedial Areas	Sidewalks
51 Eames St. Property Boundary	Structure
Railroad	Surface Water
Paved Road	Wooded Areas
Unpaved Road	Wetland Boundary

wood.

Wood
Environment & Infrastructure Solutions
271 Mill Road
Chelmsford, MA 01824

N

0 50 100 200
Feet

Figure 4.2-1
Alternative TMP 2 - Limited Action (Institutional Controls, including Vapor Intrusion Evaluations or Vapor Barriers and/or SSDSs)

OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

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Legend

- Air Sparge Well
- SVE Well
- Conveyance Piping
- TMP Remedial Areas
- 51 Eames St. Property Boundary
- Railroad
- Paved Road
- Unpaved Road
- Structures
- Surface Water
- Wetland Boundary

Note:
The limits of institutional controls and extents of remedies including capping, excavation, and/or vapor barriers/depressurization systems will be based on pre-design investigation and subsequent data evaluation.

wood.

Wood
Environment & Infrastructure Solutions
271 Mill Road
Chelmsford, MA 01824

N

0 40 80 160
Feet

Figure 4.2-2
Alternative TMP 3 -
Air Sparge/Soil Vapor Extraction
OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

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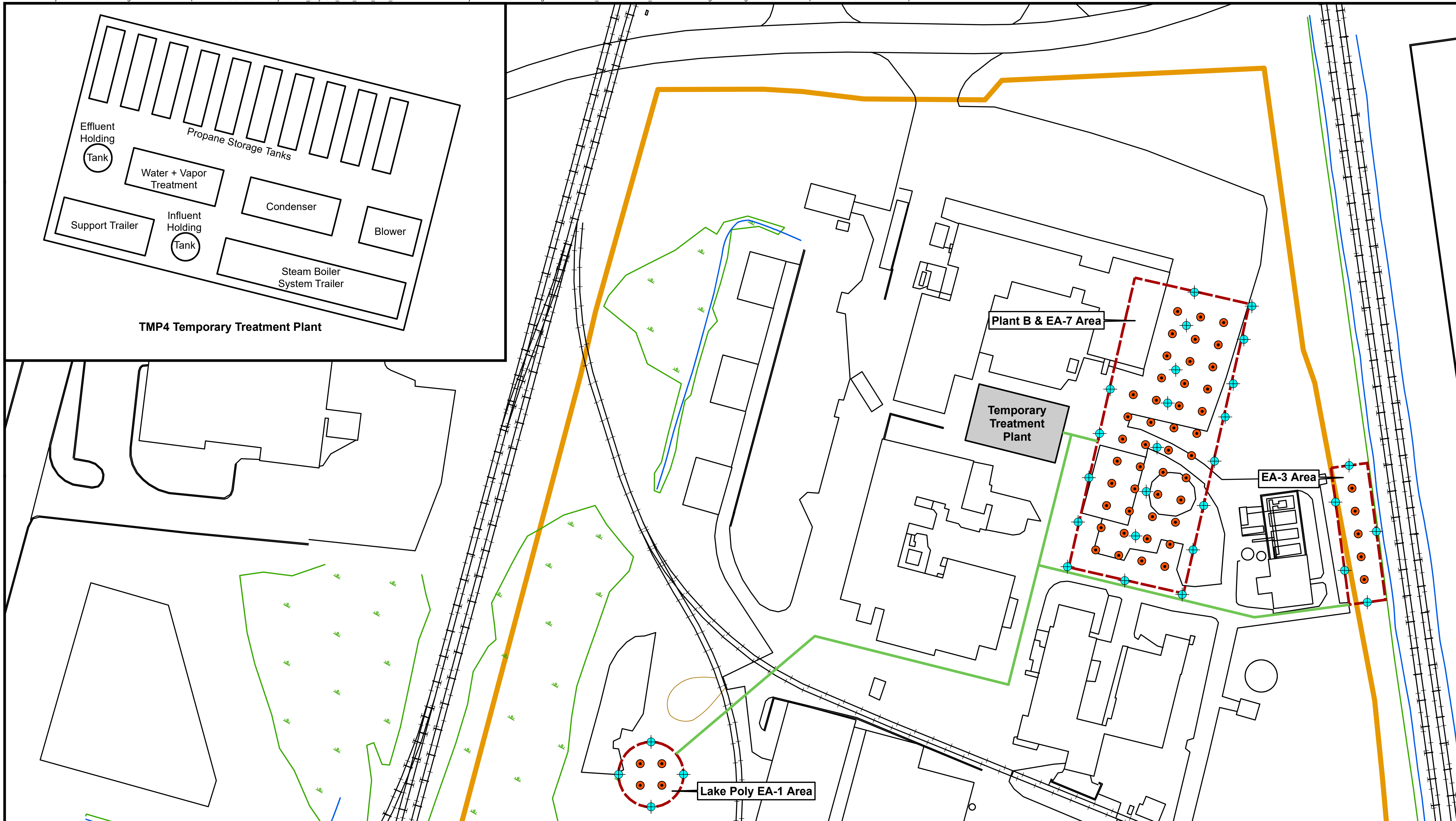

Legend

- Steam Injection Point
- Dual-Phase Extraction Well
- Conveyance Piping
- TMP Remedial Areas
- 51 Eames St. Property Boundary
- Railroad
- Paved Road
- Unpaved Road
- Structures
- Surface Water
- Wetland Boundary

Note:
The limits of institutional controls and extents of remedies including capping, excavation, and/or vapor barriers/depressurization systems will be based on pre-design investigation and subsequent data evaluation.

wood.

Wood
Environment & Infrastructure Solutions
271 Mill Road
Chelmsford, MA 01824

N

0 40 80 160
Feet

Figure 4.2-3
Alternative TMP 4 -
In-Situ Thermal Treatment
OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

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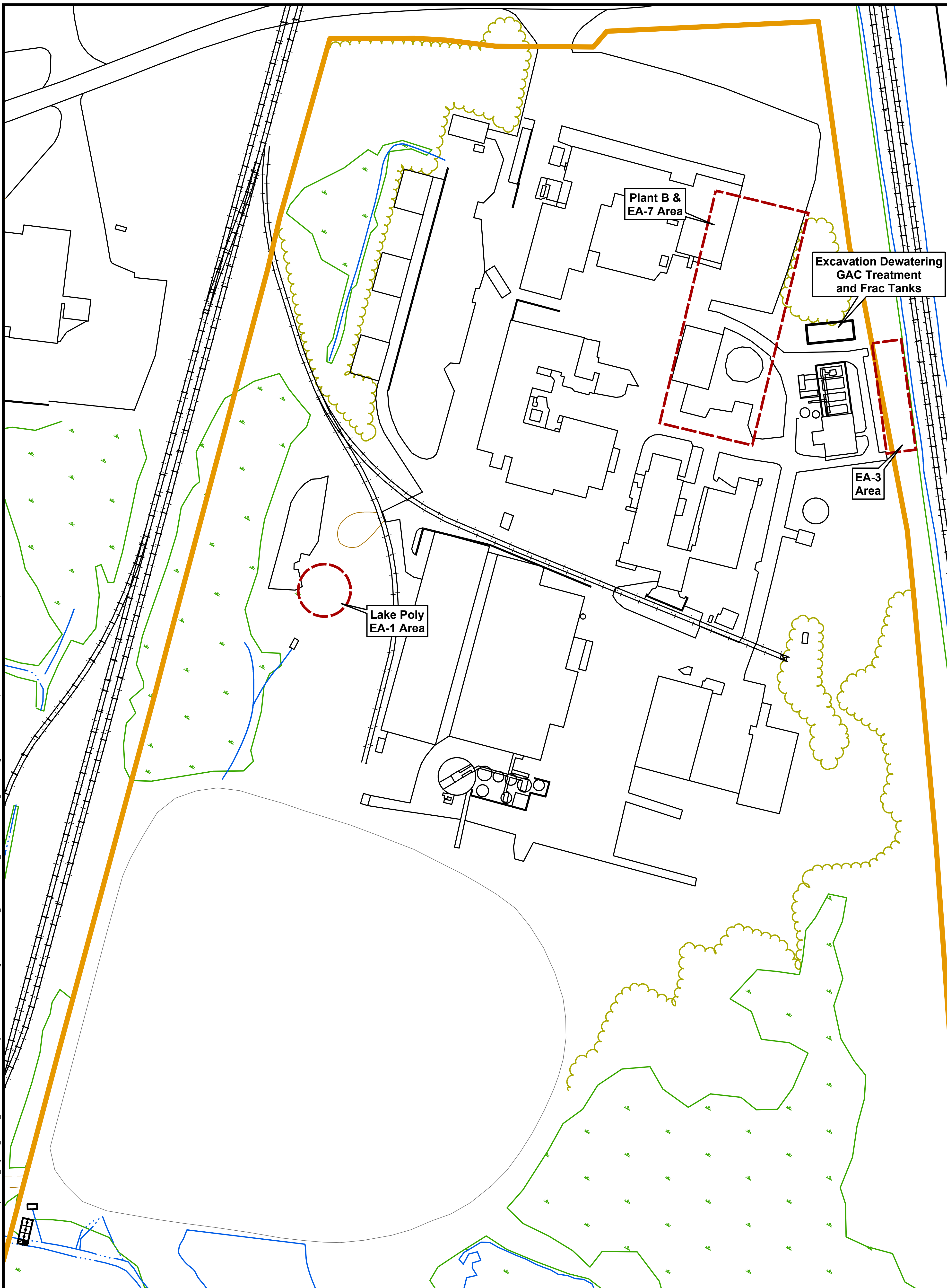

Note:
The limits of institutional controls and extents of remedies including capping, excavation, and/or vapor barriers/depressurization systems will be based on pre-design investigation and subsequent data evaluation.

Legend

- TMP Remedial Areas
- 51 Eames St. Property Boundary
- Railroad
- Paved Road
- Unpaved Road
- Sidewalks
- Structure
- Surface Water
- Wooded Areas
- Wetland Boundary

wood.

Wood
Environment & Infrastructure Solutions
271 Mill Road
Chelmsford, MA 01824

N

0 50 100 200
Feet

Figure 4.2-4
Alternative TMP 5 -
Excavation and Off-Site Disposal

OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

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Note:
The limits of institutional controls and extents of remedies including capping, excavation, and/or vapor barriers/depressurization systems will be based on pre-design investigation and subsequent data evaluation.

Legend

Area Proposed for Asphalt Cap
Area Proposed for Soil Cap

Upland Soils 0-1':
- Below Both PRGs
- Above BEHP PRG (3 mg/kg)
- Above Chromium PRG (1000 mg/kg)
- Above Both PRGs

Containment Area Soil
Upland Soil
Wetland Soil
Considered to be Sediment
51 Eames St. Property Boundary

Water
Railroad
Paved Road
Unpaved Road
Wetland Boundary

Wood
Environment & Infrastructure Solutions
271 Mill Road
Chelmsford, MA 01824

N

0 80 160 Feet

Figure 4.3-1
Alternative Soil 2 and 3 -
Cover Systems/Excavation (0-1 ft)
and Cover Systems
OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

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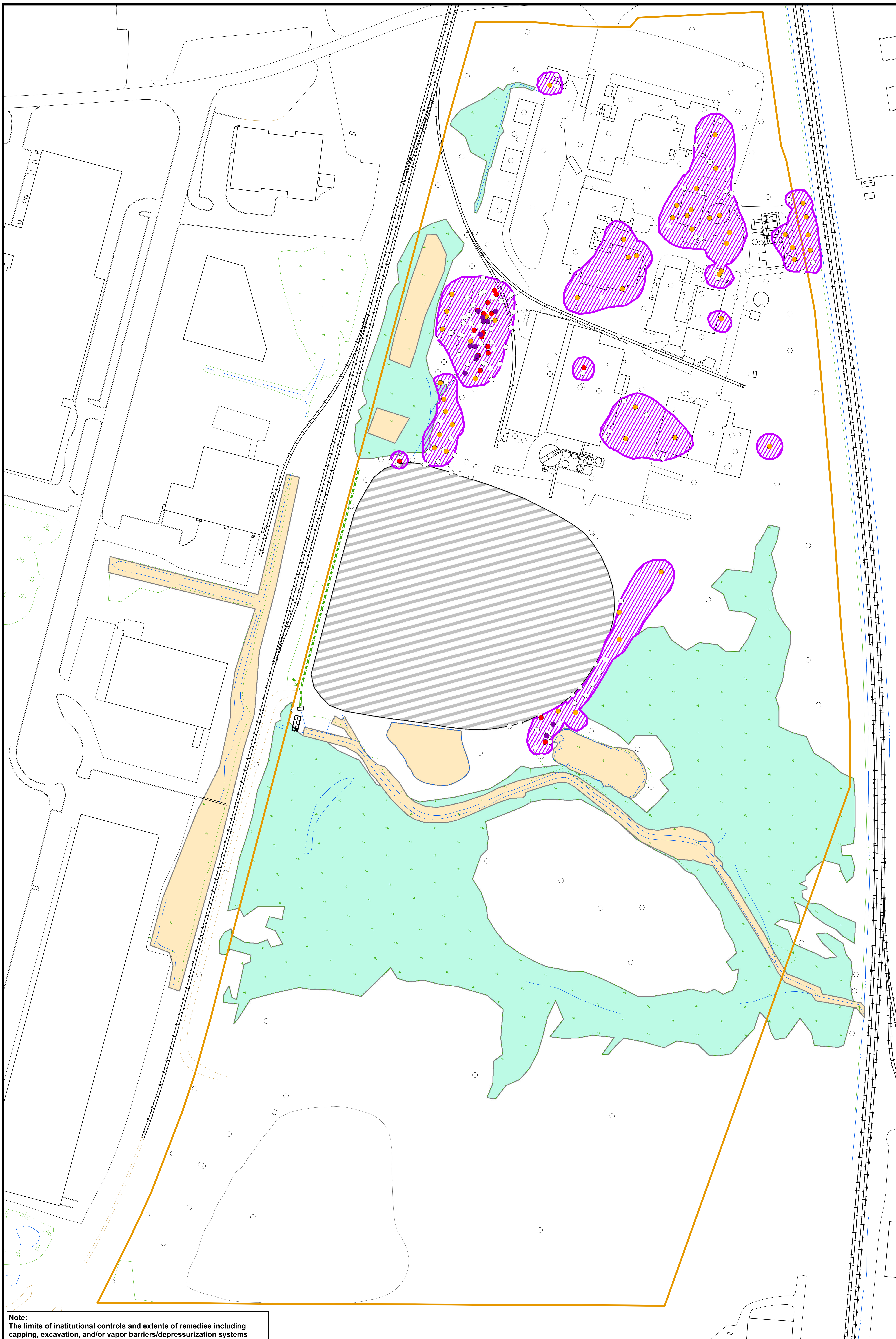

Note:
The limits of institutional controls and extents of remedies including capping, excavation, and/or vapor barriers/depressurization systems will be based on pre-design investigation and subsequent data evaluation.

Legend

Estimated Remediation Areas
Upland Soils 0-10':
- Below Both PRGs
- Above BEHP PRG (3 mg/kg)
- Above Chromium PRG (1000 mg/kg)
- Above Both PRGs

Containment Area Soil
Upland Soil
Wetland Soil
Considered to be Sediment

51 Eames St. Property Boundary
Water
Railroad

Paved Road
Unpaved Road
Wetland Boundary

Wood
Environment & Infrastructure Solutions
271 Mill Road
Chelmsford, MA 01824

N

0 80 160
Feet

Figure 4.3-2
Alternative Soil 4 -
Excavation (0-10 ft) and Off-Site Disposal

OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared/Date: BRP 07-23-20	Checked/Date: BKH 07-23-20

Note:
The limits of institutional controls and extents of remedies including capping, excavation, and/or vapor barriers/depressurization systems will be based on pre-design investigation and subsequent data evaluation.

Legend

Sediment & Wetland Soils:
- Below Both PRGs
- Above BEHP PRG
- Above Chromium PRG
- Above Both PRGs

- Estimated Wetland Excavation Area
- Estimated Sediment Excavation Area
- Containment Area Soil
- Upland Soil
- Wetland Soil
- Considered to be Sediment

- 51 Eames St. Property Boundary
- Water
- Railroad
- Paved Road
- Unpaved Road
- Wetland Boundary

PRGs:	BEHP	Chromium
Wetland Soils:	20 mg/kg	600 mg/kg
Sediment:	100 mg/kg	100 mg/kg

Wood
Environment & Infrastructure Solutions
271 Mill Road
Chelmsford, MA 01824

N

0 80 160 Feet

Figure 4.4-1
Alternative WSS 2 -
Excavation and Off-Site Disposal

OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

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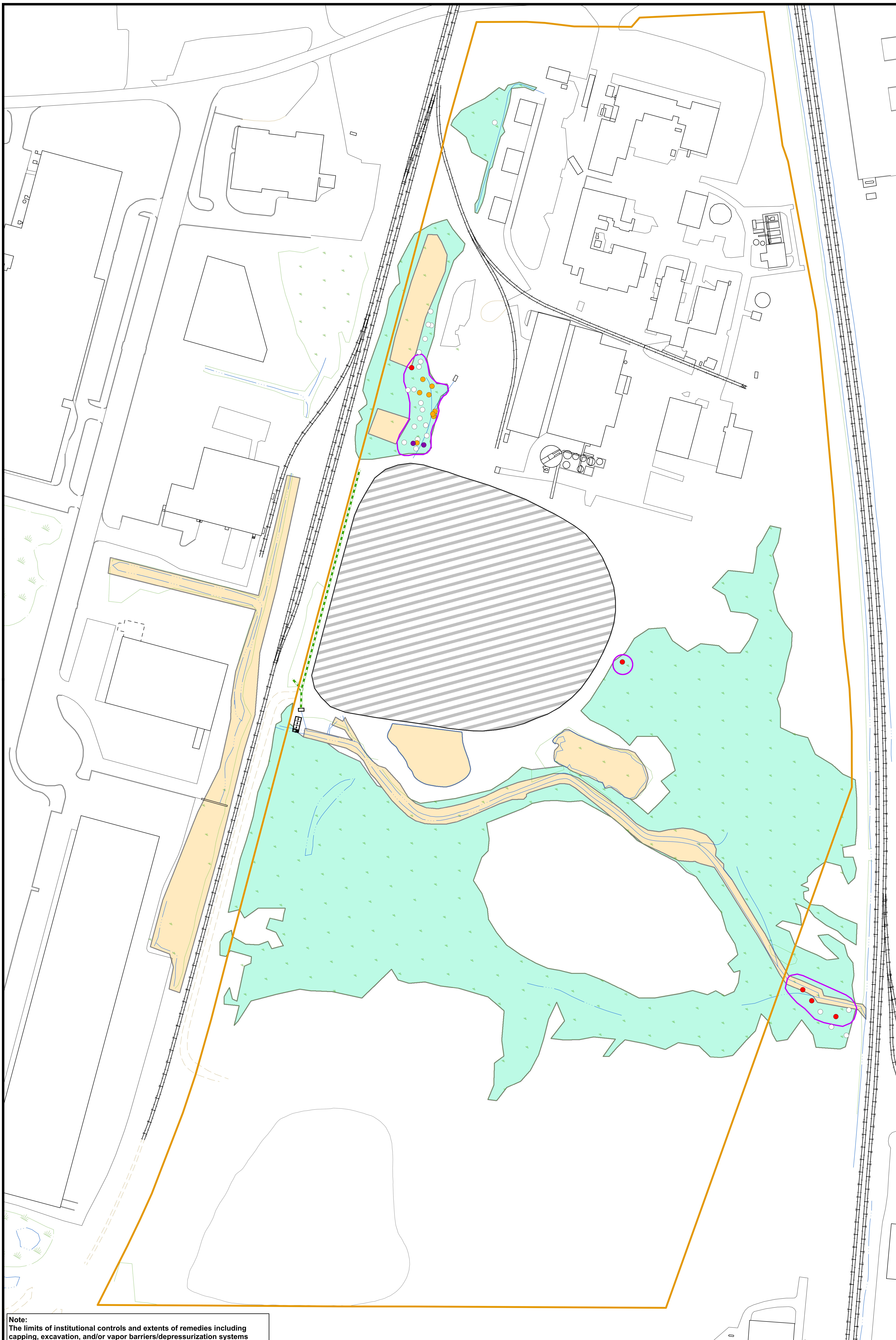

Note:
The limits of institutional controls and extents of remedies including capping, excavation, and/or vapor barriers/depressurization systems will be based on pre-design investigation and subsequent data evaluation.

Legend

Wetland Soils 1-10':
- Below Both PRGs
- Above BEHP PRG (20 mg/kg)
- Above Chromium PRG (600 mg/kg)
- Above Both PRGs
- Estimated Deed Restriciton Areas

- Containment Area Soil
- Upland Soil
- Wetland Soil
- Considered to be Sediment

- 51 Eames St. Property Boundary
- Water
- Railroad

- Paved Road
- Unpaved Road
- Wetland Boundary

wood.

Wood
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271 Mill Road
Chelmsford, MA 01824

N

0 80 160
Feet

Figure 4.4-2
Alternative WSS 2 -
Wetland Areas 0-1' for Institutional Controls

OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

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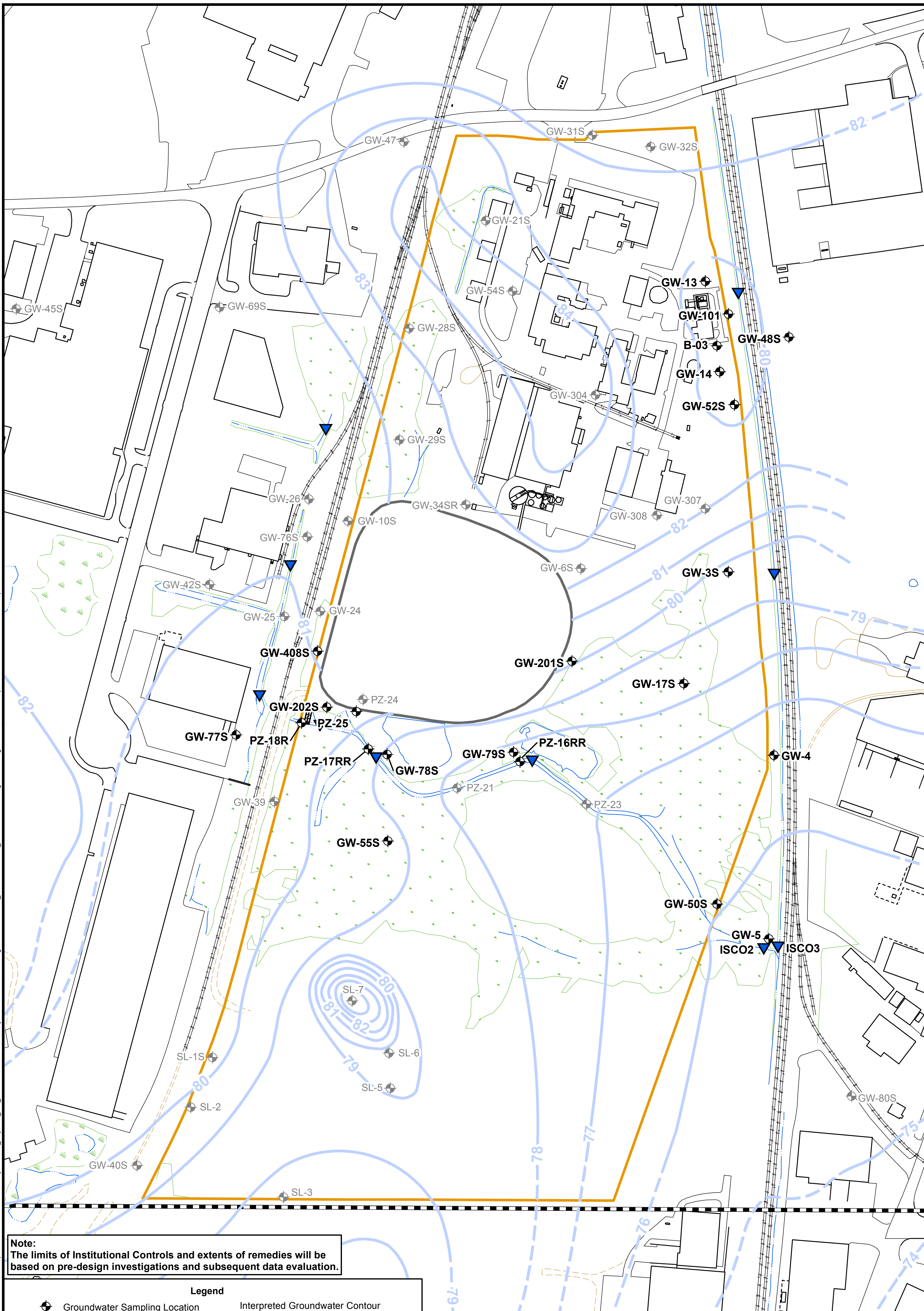

Note:
The limits of Institutional Controls and extents of remedies will be based on pre-design investigations and subsequent data evaluation.

Legend

- Groundwater Sampling Location
- Surface Water Sampling Location
- Shallow Monitoring Well Location
- Interpreted Groundwater Contour (Dashed where inferred)
- Slurry Wall
- Wilmington/Woburn Town Line
- 51 Eames St. Property Boundary
- Water
- Railroad
- Paved Road
- Unpaved Road
- Wetland Boundary

wood.

Wood
Environment & Infrastructure Solutions
271 Mill Road
Chelmsford, MA 01824

N

0 100 200 400
Feet

Figure 4.5-1
Alternative SW 2 -
Limited Action – Surface Water and Groundwater Monitoring
OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

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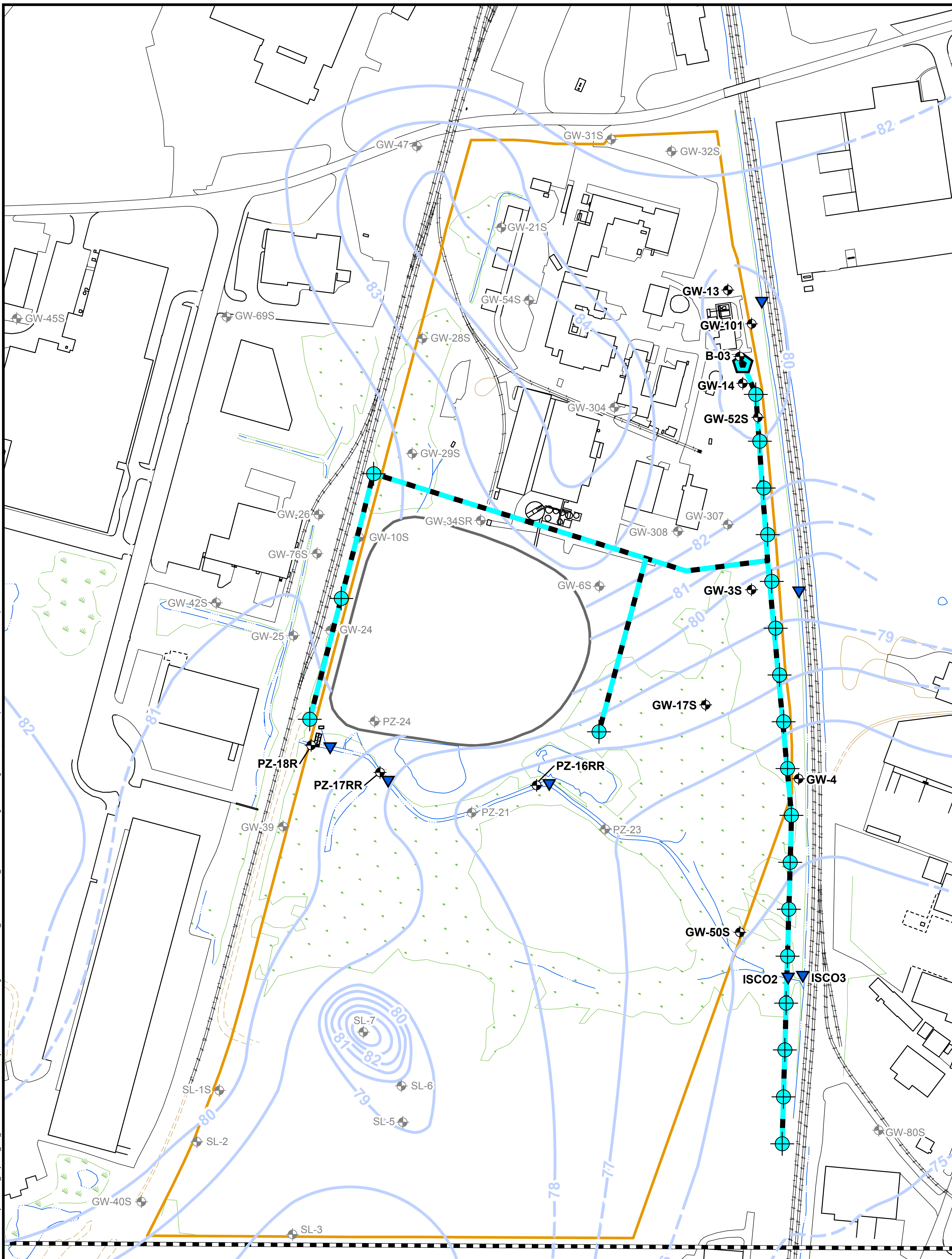

The limits of Institutional Controls and extents of remedies, including the final number and location of extraction wells, will be based on pre-design investigations and subsequent data evaluation.

Legend

- Proposed Extraction Well
- Proposed Treatment Plant
- Proposed Underground Piping
- Groundwater Sampling Location
- Surface Water Sampling Location
- Shallow Monitoring Well Location
- Interpreted Groundwater Contour (Dashed where inferred)
- Slurry Wall
- Wilmington/Woburn Town Line
- 51 Eames St. Property Boundary
- Water
- Railroad
- Paved Road
- Unpaved Road
- Wetland Boundary

wood.

Wood
Environment & Infrastructure Solutions
271 Mill Road
Chelmsford, MA 01824

N

0 100 200 400 Feet

Figure 4.5-2
Alternative SW 3 -
Groundwater Extraction and Treatment

OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

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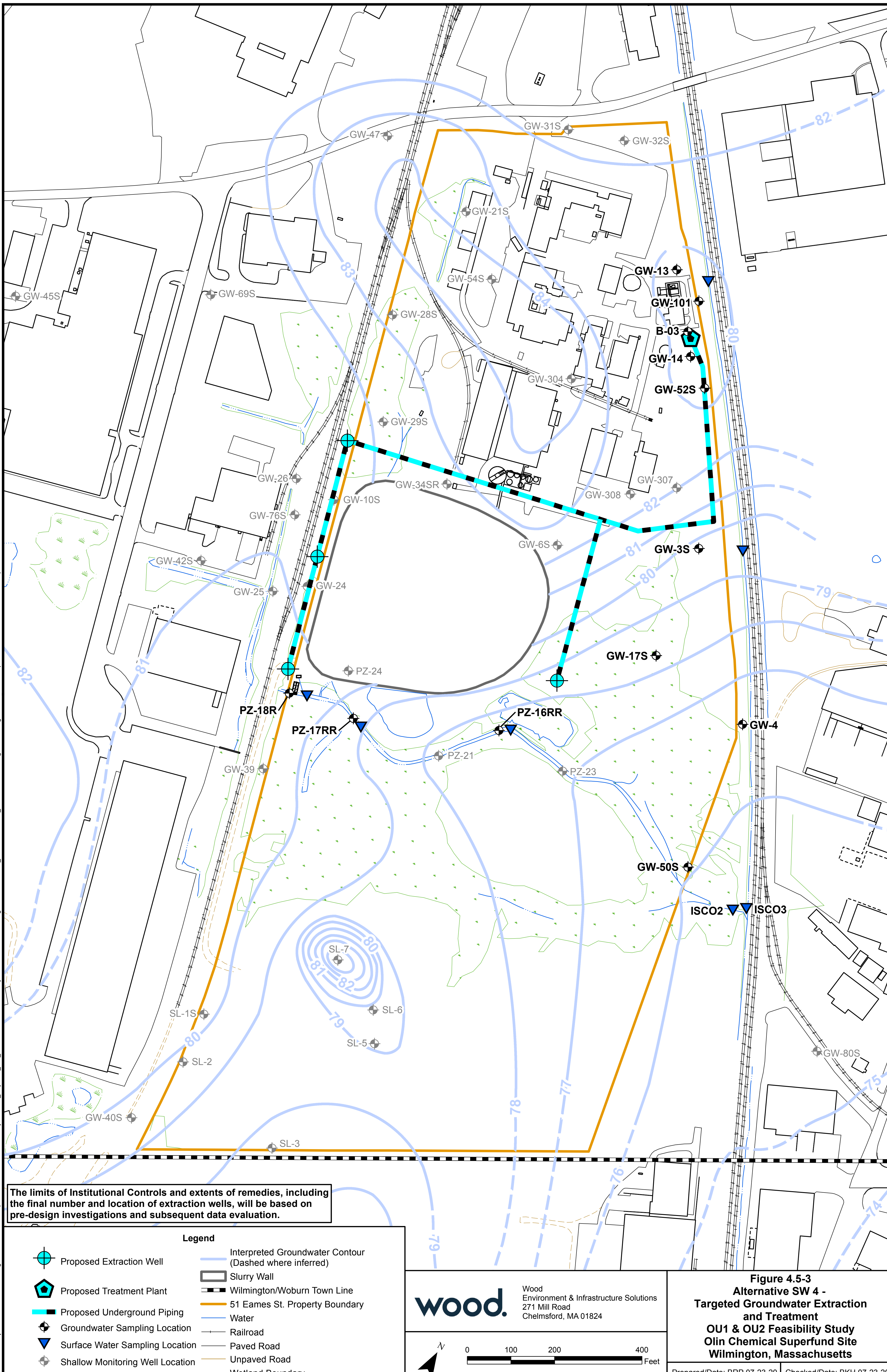

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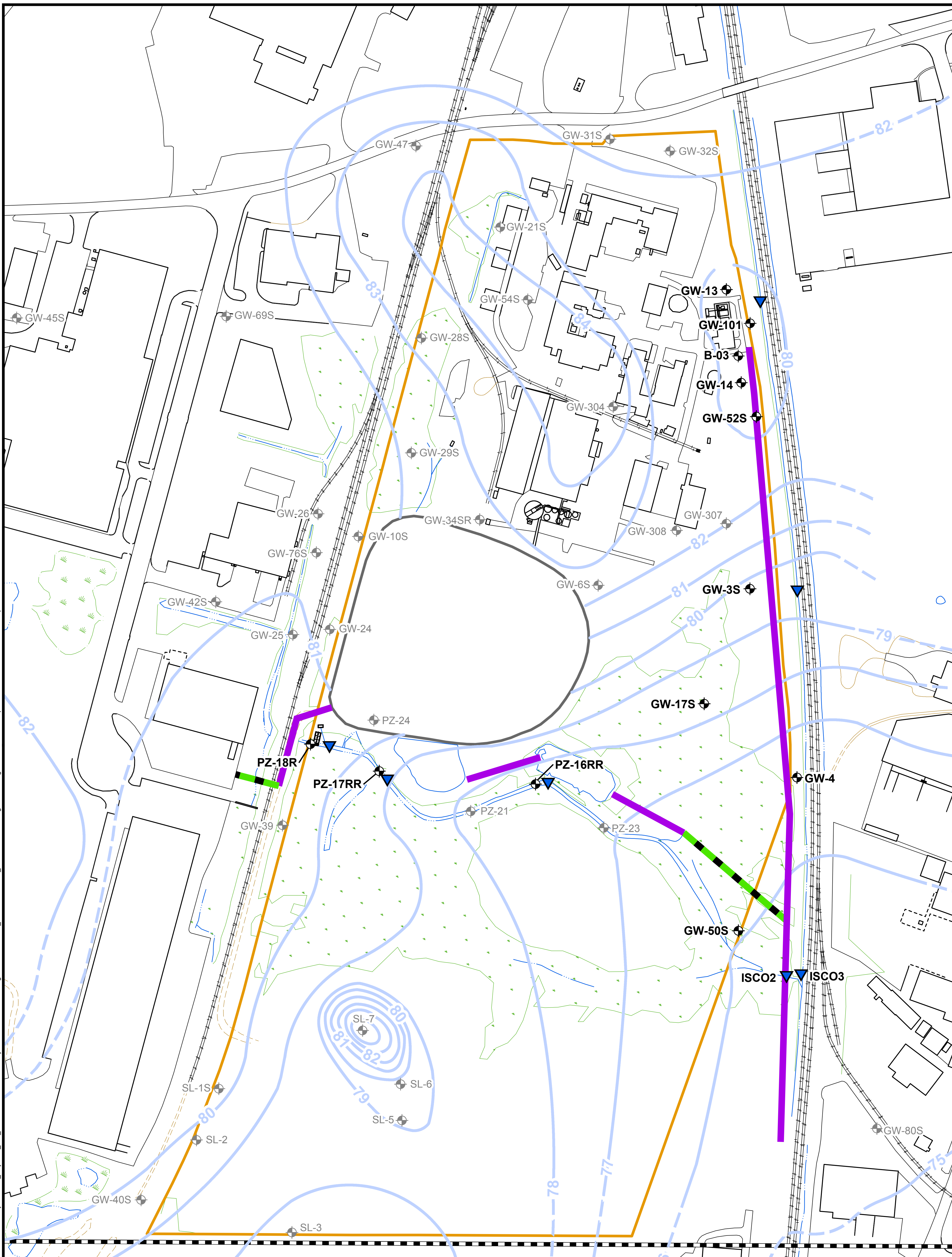

Note:
The limits of Institutional Controls and extents of remedies will be based on pre-design investigations and subsequent data evaluation.

Legend

- Grouted Sheet Pile Wall
- Permeable Reactive Barrier
- Groundwater Sampling Location
- Surface Water Sampling Location
- Shallow Monitoring Well Location
- Interpreted Groundwater Contour (Dashed where inferred)
- Slurry Wall
- Wilmington/Woburn Town Line
- 51 Eames St. Property Boundary
- Water
- Railroad
- Paved Road
- Unpaved Road
- Wetland Boundary

wood.

Wood
Environment & Infrastructure Solutions
271 Mill Road
Chelmsford, MA 01824

N

0 100 200 400 Feet

Figure 4.5-4
Alternative SW 5 -
Permeable Reactive Barrier

OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

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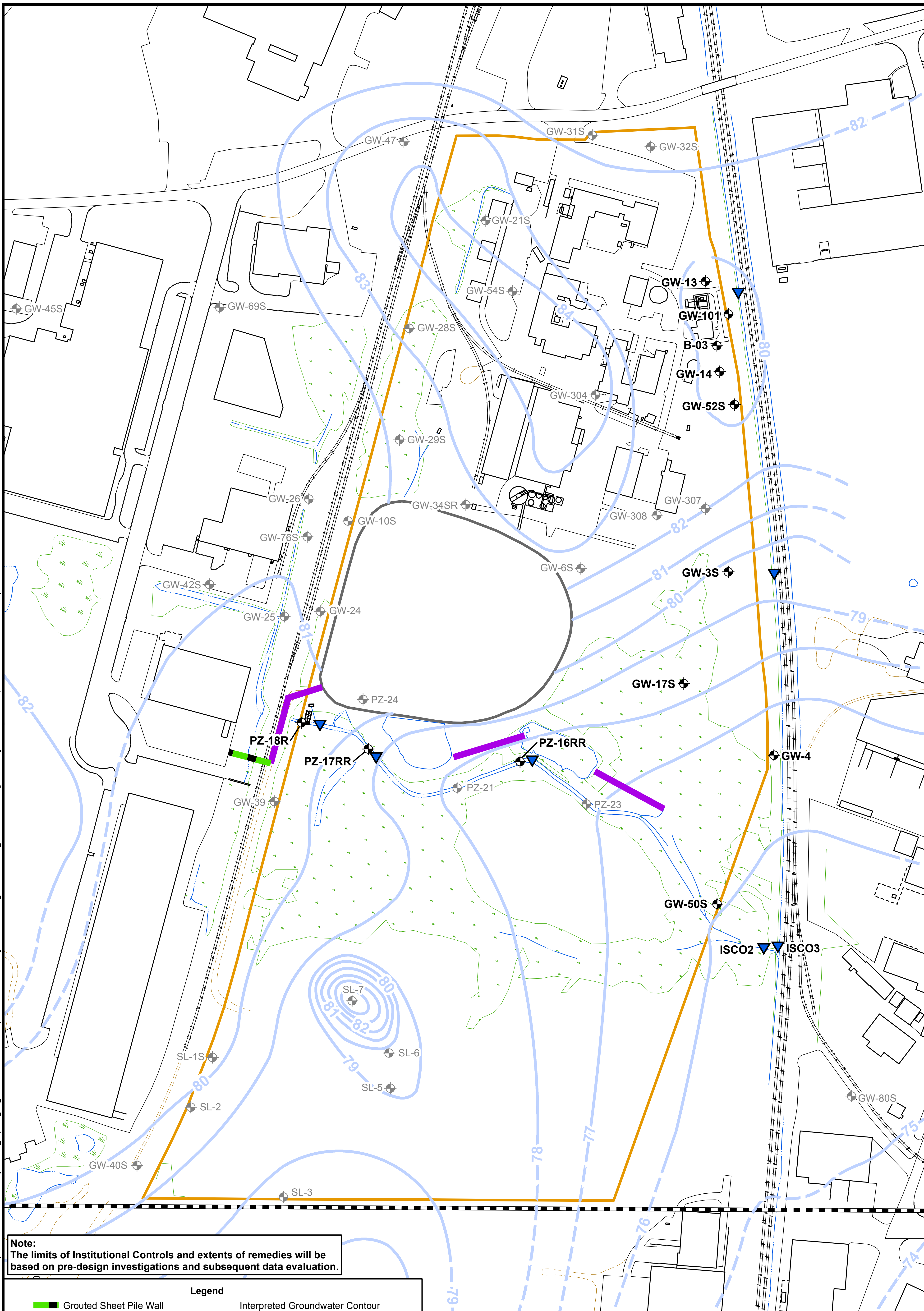

Note:
The limits of Institutional Controls and extents of remedies will be based on pre-design investigations and subsequent data evaluation.

Legend

- Grouted Sheet Pile Wall
- Permeable Reactive Barrier
- Groundwater Sampling Location
- Surface Water Sampling Location
- Shallow Monitoring Well Location
- Interpreted Groundwater Contour (Dashed where inferred)
- Slurry Wall
- Wilmington/Woburn Town Line
- 51 Eames St. Property Boundary
- Water
- Railroad
- Paved Road
- Unpaved Road
- Wetland Boundary

wood.

Wood
Environment & Infrastructure Solutions
271 Mill Road
Chelmsford, MA 01824

N

0 100 200 400
Feet

Figure 4.5-5
Alternative SW 6 -
Targeted Approach for
Permeable Reactive Barrier Installation
OU1 & OU2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

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Tables

Table 2.1-1
Location-Specific ARARs, Criteria, Advisories, and Guidance; TMPs in Soil
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement	TMPs in Soil Alternatives				
						TMP 1 - No Action	TMP 2 - Limited Action (ICs, including VI Evaluations or and Vapor Barrier/SSDS)	TMP 3 - Air Sparging/SVE System	TMP 4 - In-Situ Thermal Treatment	TMP 5 - Excavation/Off-Site Disposal
Federal Standards										
Endangered Species	Endangered Species Act	16 U.S.C. §§ 1531 et seq.; 50 CFR §§ 17.11-17.12; 50 CFR Part 402	Applicable, if endangered species are encountered	This act requires action to avoid jeopardizing the continued existence of listed endangered or threatened species or modification of their habitat.	No known endangered species have been identified in the vicinity of the OCSS. However, protection of endangered species and their habitat will be considered during development and design of remedial alternatives.	No action, therefore not applicable.	No endangered or threatened species have been identified at the Site to date. If endangered or threatened species in the remedial area are identified, remedial activities would avoid actions that adversely affect endangered or threatened species or their habitats.			
Historical/ Archeological Resources	National Historic Preservation Act	54 USC §§ 300101 et seq., 36 CFR Part 800	Applicable, if subject historical resources are present	When a federal agency finds, or is notified, that its activities may have adverse effects on historic properties, such agency is required to consult with federal and state historic preservation officials to resolve the adverse effects, including avoidance, minimization, or mitigation of the adverse effects.	If protected resources are identified in the Site area, measures to avoid, minimize and/or mitigate any adverse effects to protected resources will be implemented in consultation with federal and state historic preservation officials.	No action, therefore not applicable.	If protected resource areas are identified in the remedial area, measures to avoid, minimize and/or mitigate any impacts to protected resource areas will be implemented in consultation with federal historic preservation officials.			
Atlantic Flyway	Migratory Bird Treaty Act	16 USC § 703 et seq.	Applicable, if subject protected species are present	Protects migratory birds, their nests and eggs. A depredation permit issued by the U.S. Fish and Wildlife Service (USFWS) is required to take, possess, or transport migratory birds or disturb their nests, eggs, or young.	Remedial activities will be evaluated to protect migratory birds, their nests and eggs. If migratory bird protected areas are identified in the site area, measures to avoid, minimize and/or mitigate any impacts to protected resource areas will be implemented in consultation with appropriate USFWS officials.	No action, therefore not applicable.	If migratory bird protected areas are identified within the remedial area, measures to avoid, minimize and/or mitigate any impacts to protected resource areas will be implemented in consultation with appropriate USFWS officials.			
State Standards										
Floodplains, Wetlands, Surface Waters	Massachusetts Wetland Protection Act and Regulations	MGL c. 131, § 40; 310 CMR 10.00	Applicable if alternative alters wetlands or floodplains	These regulations restrict dredging, filling, altering, or polluting inland wetland resource areas (defined as areas within the 100-year floodplain) and buffer zones (100 feet of a vegetated wetland or 200 feet from a perennial stream), and impose performance standards for work in such areas. Protected resource areas include: 10.54 (Bank); 10.55 (Bordering Vegetated Wetlands); 10.56 (Land under Water Bodies and Waterways); 10.57 (Land	Any remedial activity conducted within 100 feet of a state regulated wetland resource area or 200 feet from a perennial stream will comply with the substantive requirements of these regulations. Mitigation of impacts on state wetland resource areas will be addressed.	No action, therefore not applicable.	Not applicable	Under these alternatives, any remedial activity conducted within 100 feet of a state regulated wetland resource area or 200 feet from a perennial stream will comply with the substantive requirements of these regulations, including, but not limited to, appropriate avoidance, minimization, mitigation and restoration of state wetland resource areas		
Endangered Species	Massachusetts Endangered Species Regulations	321 CMR 10.00	Applicable, if endangered species are encountered	Requires action to regulate the impact to state listed endangered or threatened species or their habitats. Actions must be conducted in a manner that minimizes the impact to Massachusetts-listed rare, threatened, or endangered species, and species listed by the Massachusetts Natural Heritage Program.	No known endangered species have been identified in the vicinity of the Site. However, if identified, protection of state listed endangered species and their habitat will be considered during design and implementation of remedial alternatives.	No action, therefore not applicable.	No endangered or threatened species have been identified at the Site to date. If state listed endangered or threatened species in the site area are identified, remedial activities would avoid actions that adversely affect endangered or threatened species or their habitats.			

Table 2.1-1
Location-Specific ARARs, Criteria, Advisories, and Guidance; TMPs in Soil
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement	TMPs in Soil Alternatives				
						TMP 1 - No Action	TMP 2 - Limited Action (ICs, including VI Evaluations or and Vapor Barrier/SSDS)	TMP 3 - Air Sparging/SVE System	TMP 4 - In-Situ Thermal Treatment	TMP 5 - Excavation/Off-Site Disposal
Historical/ Archeological Resources	Massachusetts Antiquities Act; Massachusetts Historical Commission Regulations; Protection of Properties Included in the State Register of Historic Places	MGL c. 9, §§ 26-27C; 950 CMR 70.00 and 71.00	Applicable, if subject historical resources are present.	Projects must eliminate, limit, or mitigate adverse effects to properties listed in the State Register of Historic Places (historic and archaeological properties). Establishes coordination with the National Historic Preservation Act.	If protected resources are identified in the Site area, measures to avoid, minimize and/or mitigate any impacts to protected resources will be implemented in consultation with federal and state historic preservation officials.	No action, therefore not applicable.	If protected resource areas are identified in the remedial area, measures to avoid, minimize and/or mitigate any impacts to protected resource areas will be implemented in consultation with federal and state historic preservation officials.			
Area of Critical Environmental Concern	Massachusetts Areas of Critical Environmental Concern (ACECs) Regulations	310 CMR 12.00	Applicable, if ACEC is identified	An ACEC is of regional, state, or national importance or contains significant ecological systems with critical interrelationships among a number of components. An eligible area must contain features from four or more of the following groups: (1) fisheries, (2) coastal features, (3) estuarine wetlands, (4) inland wetlands, (5) inland surface waters, (6) water supply areas (e.g., aquifer recharge area); (7) natural hazard areas (e.g., floodplain); (8) agricultural areas; (9) historical/archeological resources; (10) habitat resources (e.g., for endangered wildlife); or (11) special use areas. After an area is designated as an ACEC, the aim is to preserve and restore these areas.	No known ACECs have been identified at the Site. If an ACEC is identified in the Site area, activities will be controlled to minimize impacts to affected species or resources if identified.	No action, therefore not applicable.	No known ACECs have been identified at the Site. If an ACEC is identified in the remediation area, remedial activities will be controlled to minimize impacts to affected species or resources.			

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Notes:
ACEC = Areas of Critical Environmental Concern
ARAR = Applicable or Relevant and Appropriate Requirement
BMP = Best Management Practice
CFR = Code of Federal Regulations
CMR = Code of Massachusetts Regulations
CWA = Clean Water Act
DAPL = Dense Aqueous Phase Liquid
FEMA = Federal Emergency Management Agency
ICs = Institutional Controls
LEDPA = Least Environmentally Damaging Practicable Alternative
MGL = Massachusetts General Law
RCRA = Resource Conservation and Recovery Act
SSDS = Sub-Slab Depressurization System
SVE = Soil Vapor Extraction
USEPA = United States Environmental Protection Agency
USFWS = United States Fish and Wildlife Service
USC = United States Code
VI = Vapor Intrusion

Table 2.1-2
Chemical-Specific ARARs, Criteria, Advisories, and Guidance; TMPs in Soil
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement	TMPs in Soil Alternatives				
					TMP 1 - No Action	TMP 2 - Limited Action (ICs, including VI Evaluations or and Vapor Barrier/SSDS)	TMP 3 - Air Sparging/SVE System	TMP 4 - In-Situ Thermal Treatment	TMP 5 - Excavation/Off-Site Disposal
Federal Standards									
USEPA Risk Reference Doses (RfDs)	USEPA RfDs	To Be Considered	RfDs are considered to be the levels unlikely to cause significant adverse non-cancer health effects associated with a threshold mechanism of action in human exposure for a lifetime. Used in developing risk-based cleanup standards by computing human health hazard resulting from exposure to non-carcinogens at the Site.	RfDs were considered during development of PRGs.	Not applicable	Were considered in development of PRGs.			
USEPA Carcinogenic Assessment Group, Cancer Slope Factors (CSFs)	USEPA CSFs	To Be Considered	CSFs are estimates of the upper-bound probability on the increased cancer risk from a lifetime exposure to contaminants. Used in developing risk-based cleanup standards by computing the incremental cancer risk from exposure to contaminants at the Site.	CSFs were considered during development of PRGs.	Not applicable	Were considered in development of PRGs.			
Guidelines for Carcinogenic Risk Assessment	EPA/630/P-03/001F, March 2005	To Be Considered	These guidance values are to be used to evaluate the potential carcinogenic hazard caused by exposure to contaminants.	These guidelines were considered during development of PRGs.	Not applicable	Were considered in development of PRGs.			
Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens	EPA/630/R-03/003F, March 2005	To Be Considered	These guidance values are to be used to evaluate the potential carcinogenic hazard to children caused by exposure to contaminants.	These guidelines were considered during development of PRGs.	Not applicable	Were considered in development of PRGs.			
Regional Screening Levels for Chemical Contaminants at Superfund Sites	USEPA Regional Screening Levels for Chemical Contaminants at Superfund Sites	To Be Considered	Regional Screening Levels (RSLs) are risk based tools for screening contaminants at Superfund sites. RSLs are not intended to be cleanup standards.	RSLs were used to assess health risks due to exposure to chemicals in soil and to develop soil PRGs. .	Not applicable	Were considered in development of PRGs.			
Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites	OSWER 9355.4-24 (2002)	To Be Considered	EPA guidance for evaluating soil contamination. Used to develop risk-based cleanup standards, including based on the leaching of soil contaminants to groundwater.	This guidance was used to assess health risks due to exposure to chemicals in soil and to develop soil PRGs.	Not applicable	Were considered in development of PRGs.			
Soil Screening Guidance: Technical Background Document	EPA/540/R95/128 (1996)	To Be Considered	EPA guidance for evaluating soil contamination. Used to develop risk-based cleanup standards.	This guidance was used to assess health risks due to exposure to chemicals in soil and to develop soil PRGs.	Not applicable	Were considered in development of PRGs.			

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Notes:
ARAR = Applicable or Relevant and Appropriate Requirement
CSF = cancer slope factor
ICs = Institutional Controls
OSWER = Office of Solid Waste and Emergency Response
PRGs = Preliminary Remediation Goals
SSDS = Sub-Slab Depressurization System
SVE = Soil Vapor Extraction
RfD = reference dose
RSL = Regional Screening Level
USEPA = United States Environmental Protection Agency
VI = Vaport Intrusion

Table 2.1-3
Action-Specific ARARs, Criteria, Advisories, and Guidance; TMPs in Soil
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement	TMPs in Soil Alternatives				
						TMP 1 - No Action	TMP 2 - Limited Action (ICs, including VI Evaluations or and Vapor Barrier/SSDS)	TMP 3 - Air Sparging/SVE System	TMP 4 - In-Situ Thermal Treatment	TMP 5 - Excavation/Off-Site Disposal
Federal Standards										
Hazardous Waste Treatment, Storage, Disposal	Resource Conservation and Recovery Act (RCRA) Subtitle C; Hazardous Waste Identification; Generator and Handler Requirements; Tracking Requirements; Storage, Treatment and Disposal Requirements; Groundwater Monitoring Requirements; Closure and Post Closure Requirements	42 USC § 6901 et seq.; 40 CFR Parts 260-262, Part 264	Applicable, if hazardous waste is generated.	Federal standards used to identify, manage, and dispose of hazardous waste. Massachusetts has been delegated the authority to administer these RCRA standards through its state hazardous waste management regulations.	Any wastes generated during remedial activities will be analyzed under these standards to determine whether they are listed or characteristic hazardous waste. Non-hazardous wastes will be disposed of appropriately. Any waste generated during remedial activities that is determined to be hazardous waste will be managed in accordance with these regulations. Alternatives generating hazardous waste or using treatment, storage or disposal facilities for hazardous waste will be implemented to comply with this ARAR.	No action, therefore not applicable.	Not applicable, no waste will be generated.	Soil excavated for conveyance lines or generated during well installation will be analyzed under these standards to determine whether it contains characteristic hazardous waste and will be managed in accordance with these regulations, including for storage, off-site transportation, and disposal.		Excavated soil will be analyzed under these standards to determine whether it contains characteristic hazardous waste and will be managed in accordance with these regulations, including for storage, off-site transportation, and disposal.
Hazardous Waste - Air Emissions	RCRA, Air Emission Standards for Process Vents; Equipment Leaks; Tanks, Surface Impoundments, and Containers	40 CFR Part 264, Subparts AA, BB, and CC	Applicable, if hazardous wastes: will be managed by process vents with volatile organic concentrations of at least 10 parts per million by weight (ppmw) (Subpart AA); will be managed by equipment with organic concentrations of at least 10% by weight (Subpart BB); or will be managed in tanks, surface impoundments, or containers, and thresholds are met (Subpart CC). Relevant and Appropriate, if organics less than thresholds or for non-hazardous waste. Relevant and Appropriate, if less than thresholds.	RCRA emissions standards not delegated to the State. Standards for process vents for systems that manage hazardous wastes that have organic concentrations of at least 10 ppmw. Standards for air equipment leaks for systems that manage hazardous wastes with organic concentrations of at least 10% by weight. Standards for tanks, surface impoundments, and containers that manage hazardous wastes with average VOC concentrations of 500 ppm by weight or greater.	Process vents, air equipment, tanks, surface impoundments or containers will be managed in accordance with these air emission regulations.	No action, therefore not applicable.	This ARAR may need to be considered in the design and implementation of engineering controls (ECs) for future buildings	Management of VOCs in excavated soil would be in accordance with these air emission regulations		Management of VOCs in excavated soil would be in accordance with these air emission regulations
Air Emissions	Clean Air Act (CAA), Hazardous Air Pollutants; National Emission Standards for Hazardous Air Pollutants (NESHAPs)	42 USC § 112(b)(1); 40 CFR Part 61	Applicable	These regulations establish emissions standards for 189 hazardous air pollutants.	No air emissions from remedial activities, such as soil excavation, would cause air quality standards to be exceeded. Dust standards would be complied with during remedial activities.	No action, therefore not applicable.	This ARAR will need to be considered in the design and implementation of ECs for future buildings.	These alternatives will comply with the ARAR by ensuring that dust standards are not exceeded during remedial activities, and the associated air emissions standards will also be met during excavation and/or emissions from treatment systems		
Discharges to Surface Water; Storm Water Controls	Clean Water Act; National Pollutant Discharge Elimination System (NPDES)	40 CFR Parts 122 and 125	Applicable (and if surface water discharge occurs, discharge standards are also applicable)	These requirements include storm water standards for construction activities disturbing more than one acre and requirements for stormwater discharges from hazardous waste treatment, storage, and disposal facilities. These requirements also specify the permissible concentration or level of contaminants in the discharge from any point source to waters of the United States.	Best management practices will be used to control and manage stormwater runoff during construction and operation. Alternatives that incorporate discharges to surface waters will need to have the discharges meet the substantive discharge standards (the Massachusetts Surface Water Discharge Permit Program [314 CMR 3.00] has similar requirements).	No action, therefore not applicable	Not applicable, no water discharge to surface water	Any discharge to surface water from soil excavation/management, excavation dewatering, or treatment systems will be treated to meet these standards		

Table 2.1-3
Action-Specific ARARs, Criteria, Advisories, and Guidance; TMPs in Soil
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement	TMPs in Soil Alternatives				
						TMP 1 - No Action	TMP 2 - Limited Action (ICs, including VI Evaluations or and Vapor Barrier/SSDS)	TMP 3 - Air Sparging/SVE System	TMP 4 - In-Situ Thermal Treatment	TMP 5 - Excavation/Off-Site Disposal
Discharge to a Publicly Owned Treatment Works (POTW)	General Pretreatment Regulations for Existing and New Sources of Pollution	40 CFR Part 403	Applicable, if discharge to a POTW occurs	Standards for discharge into a Publicly Owned Treatment Works (POTW).	If remedial activities result in discharges to a POTW, the discharge will be monitored and treated, if necessary, to comply with pretreatment standards.	No action, therefore not applicable.	Not applicable, no water discharge to POTW	Any water generated during soil excavation/ management, excavation dewatering, or treatment systems will be treated, if necessary, to meet these standards, if the water is to be discharged to a POTW.		
Investigation-Derived Waste (IDW)	Guide to Management of Investigation-Derived Wastes	USEPA OSWER Publication 9345.3-03FS, January 1992	To Be Considered	Guidance on management of IDW in a manner that ensures protection of human health and the environment.	IDW generated as part of this remedial alternative will be managed based on guidance standards.	No action, therefore not applicable.	Not applicable, no IDW will be generated.	IDW generated as part of pre-design investigations for these remedies will by managed in compliance with this guidance.		
Vapor Intrusion	OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air.	OSWER 9200.2-154 (June 2015)	To Be Considered	EPA guidance for addressing vapor intrusion issues at CERCLA sites.	This guidance will be considered during development and implementation of remedial alternatives related to vapor intrusion.	No action, therefore not applicable.	ECs will be designed and implemented to eliminate vapor intrusion issues.	Not applicable, soil will be removed or treated prior to development so that there are no vapor intrusion issues.		
State Standards										
Hazardous Waste Identification	Massachusetts Hazardous Waste Management Rules for Identification and Listing of Hazardous Wastes	310 CMR 30.100	Applicable, if hazardous waste is generated	Massachusetts is delegated to administer RCRA through its state regulations. These regulations establish requirements for determining whether wastes are either listed or characteristic hazardous waste.	These Massachusetts regulations supplement federal RCRA requirements. Any wastes generated during remedial activities will be analyzed under these standards to determine whether they are listed or characteristic hazardous wastes. Hazardous and nonhazardous wastes will be managed and disposed of appropriately.	No action, therefore not applicable.	Not applicable, no hazardous waste will be generated as part of this alternative.	All soil determined to contain hazardous waste that is excavated will be managed as a hazardous waste in accordance with these regulations.		
Hazardous Waste - Generator Standards	Massachusetts Hazardous Waste Rules – Requirements for Generators	310 CMR 30.300	Applicable, if hazardous waste is generated	These regulations contain requirements for hazardous waste generators. The regulations apply to generators of sampling waste and also apply to the accumulation of waste prior to off-site disposal.	If any remedial activity generates hazardous wastes, the wastes will be managed in accordance with the substantive requirements of these regulations.	No action, therefore not applicable.	Not applicable, no hazardous waste will be generated as part of this alternative.	All soil determined to be hazardous waste will be managed in accordance with these regulations.		
Hazardous Waste - Waste Piles	Massachusetts Hazardous Waste Rules – Waste Piles	310 CMR 30.640	Applicable, if hazardous waste is managed in waste piles	310 CMR 30.641 through 30.649 prescribe requirements for storage and treatment of hazardous waste in waste piles. Provides specifications for inter alia design and operations, monitoring and inspection, and closure and post-closure care.	Any hazardous wastes that may be generated during remedial activities will be managed in accordance with these regulations.	No action, therefore not applicable	Not applicable, no hazardous waste will be generated as part of this alternative.	Excavated soil that is determined to be hazardous waste will be managed in accordance with these regulations. Under these alternatives, any treatment or storage of hazardous waste will comply with this ARAR through appropriate design and operation.		
Hazardous Waste - Groundwater	Massachusetts Hazardous Waste Rules – Groundwater Protection	310 CMR 30.660	Applicable, if hazardous waste is managed in a regulated unit	310 CMR 30.661 through 30.673 prescribe requirements for regulated units that receive hazardous waste, except for certain waste piles, to protect groundwater.	Any hazardous waste generated by the remedial alternative will be managed to prevent contaminant migration to groundwater.	No action, therefore not applicable.	Not applicable, no hazardous waste will be generated as part of this alternative.	Excavated soil that is determined to be hazardous waste will be managed in accordance with these regulations. Under these alternatives, any treatment or storage of hazardous waste will comply with this ARAR through appropriate design and operation.		

Table 2.1-3
Action-Specific ARARs, Criteria, Advisories, and Guidance; TMPs in Soil
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
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Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement	TMPs in Soil Alternatives				
						TMP 1 - No Action	TMP 2 - Limited Action (ICs, including VI Evaluations or and Vapor Barrier/SSDS)	TMP 3 - Air Sparging/SVE System	TMP 4 - In-Situ Thermal Treatment	TMP 5 - Excavation/Off-Site Disposal
Hazardous Waste - Management Facility Standards	Massachusetts Hazardous Waste Rules – Management Standards for All Hazardous Waste Facilities	310 CMR 30.500	Applicable, if hazardous waste is generated	General facility requirements for waste analysis, security measures, inspections, and training requirements. Section 30.580 addresses closure. Section 30.590 addresses post-closure of hazardous waste facilities. Section 30.513 requires a general waste analysis of any hazardous waste.	Any waste generated during remedial activities that is determined to be hazardous waste will be managed in accordance with these regulations. Alternatives generating hazardous waste or using treatment, storage or disposal facilities for hazardous waste will be implemented to comply with this ARAR.	No action, therefore not applicable.	Not applicable, no hazardous waste will be generated as part of this alternative.	Excavated soil that is determined to be hazardous waste will be managed in accordance with these regulations. Under these alternatives, any treatment or storage of hazardous waste will comply with this ARAR through appropriate design and operation		
Hazardous Waste - Containers	Massachusetts Hazardous Waste Rules – Use and Management of Containers	310 CMR 30.680	Applicable, if hazardous waste is containerized	310 CMR 30.681 through 30.689 prescribe requirements for the use of containers, such as drums, to store hazardous waste. Provides specifications for inter alia labelling and marking, management of containers, inspections, and closure.	Establishes requirements for the management of containers, such as drums, that are used to store hazardous wastes. Alternatives utilizing containers of hazardous waste will comply with this ARAR.	No action, therefore not applicable.	Not applicable, no hazardous waste will be generated as part of this alternative.	Any hazardous waste generated by these remedial alternatives that is managed in containers will comply with the ARAR through appropriate design and implementation.		
Hazardous Waste - Tanks	Massachusetts Hazardous Waste Rules – Storage and Treatment in Tanks	310 CMR 30.690	Applicable, if hazardous waste is stored and/or transported in tanks	310 CMR 30.691 through 30.699 prescribe requirements for the use of tanks to store and treat hazardous waste. Provides specifications for inter alia design and installation, containment and detection of leaks, general operating requirements, inspections, and closure and post-closure care.	Alternatives utilizing tanks for storage or treatment of hazardous waste will comply with this ARAR.	No action, therefore not applicable.	Not applicable, no hazardous waste will be generated as part of this alternative.	Any hazardous waste generated by these remedial alternatives that is managed in tanks will comply with the ARAR through appropriate design and implementation.		
Air Emissions	Massachusetts Ambient Air Quality Standards	310 CMR 6.00	Applicable	These regulations establish primary and secondary standards for emissions of sulfur dioxide, particulate matter, carbon monoxide, ozone, nitrogen dioxide, and lead.	Remedial activities would be implemented in accordance with these rules. No air emissions from remedial activities would cause air quality standards to be exceeded.	No action, therefore not applicable.	This ARAR will need to be considered in the design and implementation of ECs for future buildings.	These alternatives will comply with the ARAR by ensuring that dust standards are not exceeded during remedial activities, and the associated air emissions standards will also be met during excavation and/or emissions from treatment systems.		
Air Emissions	Massachusetts Air Pollution Control Regulations	310 CMR 7.00	Applicable	These regulations set emission limits necessary to attain ambient air quality standards including standards for visible emissions (7.06); dust, odor, construction and demolition (7.09); noise (7.10); and asbestos (7.15).	Remedial activities will be implemented in accordance with these rules. No air emissions from remedial activities will cause air quality standards to be exceeded.	No action, therefore not applicable.	This ARAR will need to be considered in the design and implementation of ECs for future buildings.	These alternatives will comply with the ARAR by ensuring that dust standards are not exceeded during remedial activities, and the associated air emissions standards will also be met during excavation and/or emissions from treatment systems.		
Discharges to Surface Water	Massachusetts Clean Water Act; MA Surface Water Quality Standards (MSWQS)	M.G.L. c. 21, §§ 26-53; 314 CMR 4.00	Applicable, if surface water discharge occurs	These standards designate the most sensitive uses for which the various waters of the Commonwealth shall be enhanced, maintained, or protected. Minimum water quality criteria required to sustain the designated uses are established.	Alternatives that incorporate discharges to surface waters will need to have the discharges meet the MSWQS.	No action, therefore not applicable.	Not applicable, no water discharge to surface water.	Any discharge to surface water from soil excavation/ management, excavation dewatering, or treatment systems will be treated to meet these standards.		
Discharge to Publicly Owned Treatment Works (POTW)	Massachusetts Operation, Maintenance and Pretreatment Standards for Wastewater Treatment Works and Indirect Dischargers	314 CMR 12.00	Applicable, if discharges to a POTW occur	Standards for pretreatment requirements for sources to a POTW.	If remedial actions result in discharges to a POTW, the discharge will be monitored and treated, if necessary, to comply with pretreatment standards.	No action, therefore not applicable.	Not applicable, no water discharge to POTW.	Any water generated during soil excavation/ management, excavation dewatering, or treatment systems will be treated, if necessary, to meet these standards, if the water is to be discharged to a POTW.		

Table 2.1-3
Action-Specific ARARs, Criteria, Advisories, and Guidance; TMPs in Soil
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement	TMPs in Soil Alternatives				
						TMP 1 - No Action	TMP 2 - Limited Action (ICs, including VI Evaluations or and Vapor Barrier/SSDS)	TMP 3 - Air Sparging/SVE System	TMP 4 - In-Situ Thermal Treatment	TMP 5 - Excavation/Off-Site Disposal
Hazardous Waste - Facility Discharge Standards	Massachusetts Supplemental Requirements for Hazardous Waste Management Facilities	MGL c. 21, §§ 26-53; 314 CMR 8.00	Applicable, if hazardous waste is generated and surface water discharge occurs	This regulation establishes additional requirements that must be satisfied for a RCRA facility (a wastewater treatment works which manages hazardous waste) that has a wastewater discharge permit.	Alternatives that involve management of hazardous waste prior to discharge to surface waters will meet the substantive standards.	No action, therefore not applicable.	Not applicable, no water discharge to surface water.	Any management/treatment of hazardous waste prior to discharge to surface water will comply with the substantive standards.		
Sediment/Erosion Control; Stormwater Management	Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas	Prepared for Massachusetts Executive Office of Environmental Affairs (original print March 1997; reprint May 2003)	To Be Considered	Guidance on preventing erosion and sedimentation.	Remedial activities will be managed to control erosion and sedimentation.	No action, therefore not applicable.	This TBC will need to be considered in the design and implementation of ECs for future buildings.	These alternatives will be designed and managed to control erosion and sedimentation in accordance with this guidance		
Monitoring Wells	Massachusetts Standard References for Monitoring Wells	WSC-310-91	To Be Considered	Guidance on locating, drilling, installing, sampling and decommissioning monitoring wells	Monitoring wells will be installed, maintained and decommissioned based on these guidance standards.	No action, therefore not applicable.	Not applicable, but will need to be considered during future property redevelopment.	Monitoring wells that are required as part of these alternatives would be installed, maintained or decommissioned in accordance with this guidance.		
Air Quality	Division of Air Quality Control (DAQC)	DAQC Policy 90-001, re: Noise Regulation,	To Be Considered	Guidance on sound emissions.	The guidance will be used to assess whether any remedial measure exceed Stae noise guidance levels.	No action, therefore not applicable.	This TBC will need to be considered in the design and implementation of ECs for future buildings.	Site operations will meet this TBC.		
Discharges to Surface Waters	Massachusetts Clean Water Act; Surface Water Discharge Permit Regulations	MGL c. 21, §§ 26-53; 314 CMR 3.00	Applicable, if surface water discharge occurs	These regulations require that discharges to waters of the Commonwealth shall not result in exceedances of Massachusetts Surface Water Quality Standards (MSWQS) (314 CMR 4.00).	Any water discharged to surface waters related to excavation and dewatering activities will be treated to meet the substantive discharge standards of the Massachusetts Surface Water Discharge Permit (314 CMR 4.00).	No action, therefore not applicable.	Not applicable, no water discharge to surface water.	Any discharge to surface water from soil excavation/management, excavation dewatering, or treatment systems will be treated to meet these standards.		
Solid Waste	Massachusetts Solid Waste Management Regulations	310 CMR 19.000	Applicable, if solid waste is generated	This regulation establishes requirements for the storage, transfer, processing, treatment, disposal, use and reuse of solid waste (including asbestos), including contracting for disposal or transport of solid waste.	Any wastes generated by remedial activity that are determined to not be hazardous wastes will be managed in accordance with this regulation .	No action, therefore not applicable.	This TBC will need to be considered in the design and implementation of ECs for future buildings.	Any solid waste generated by these remedial alternatives will comply with the ARAR through appropriate design and implementation.		

Prepared By / Date: JW 03/20/2020
Checked By / Date:

Notes:
ARAR = Applicable or Relevant and Appropriate Requirement
CAA = Clean Air Act
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
CFR = Code of Federal Regulations
CMR = Code of Massachusetts Regulations
ICs = Institutional Controls
IDW = Investigation Derived Waste
NESHAP = National Emission Standards for Hazardous Air Pollutant
OSWER = Office of Solid Waste and Emergency Response
ppmw = parts per million by weight
RCRA = Resource Conservation and Recovery Act
SSDS = Sub-Slab Depressurization System
SVE = Soil Vapor Extraction
USC = United States Code
USEPA = United States Environmental Protection Agency
VI = Vapor Intrusion

Table 2.1-4
Location-Specific ARARs, Criteria, Advisories, and Guidance; Upland Soil
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement	Upland Soil Alternatives			
						Soil 1 - No Action	Soil 2 - Cover System	Soil 3 - Excavation (0-1 ft) and Cover Systems	Soil 4 - Excavation (0-10 ft) and Off Site Disposal
Federal Standards									
Floodplains and Wetlands	Floodplain Management and Protection of Wetlands	44 CFR Part 9 (implementing Executive Orders 11988 and 11990)	Applicable	Federal Emergency Management Agency (FEMA) regulations set forth the policy, procedure, and responsibilities to implement and enforce Executive Order 11988 (Floodplain Management) and Executive Order 11990 (Protection of Wetlands). These regulations prohibit activities that adversely affect a federally-regulated wetland unless there is no practicable alternative and the proposed action includes all practicable measures to minimize harm to wetlands that may result from such use. These regulations require the avoidance of impacts associated with the occupancy and modification of federally-designated 100-year and 500-year floodplains and require the avoidance of development within a floodplain wherever there is a practicable alternative. An assessment of impacts to the 500-year floodplain is required for critical actions, which includes siting waste facilities in a floodplain. These regulations require public notice when proposing any action in or affecting floodplains or wetlands.	If there is no practicable alternative method to work in federal jurisdictional wetlands, or 100-year or 500-year floodplains, then all practicable measures will be taken to minimize and mitigate any adverse impacts. Erosion and sedimentation control measures will be adopted during remedial activities to protect these wetlands and floodplains. Standards for excavating and managing contaminated soil, sediment, and groundwater/DAPL, etc. within the 100-year and 500-year floodplains will be attained. After completion of work, there will be no significant net loss of flood storage capacity and no significant net increase in flood stage or velocities. Floodplain habitat will be restored to the extent practicable. Public comment will be solicited as part of the Proposed Plan concerning any proposed alteration to wetlands and floodplains.	No action, therefore not applicable.	This alternative includes the use of soil covers in/adjacent to wetlands and floodplains and will comply with this ARAR through appropriate avoidance, minimization, mitigation and restoration. Federal jurisdictional wetlands altered by soil covers installed adjacent to such wetlands will be restored in place. All remedial work within the regulated 500-year floodplain will result in no significant net loss of flood storage capacity and no significant net increase in flood stage or velocities. Floodplain habitat will be restored, to the extent practicable.	These alternatives include excavation and restoration in/adjacent to wetlands and floodplains and will comply with this ARAR through appropriate avoidance, minimization, mitigation and restoration. No net loss of flood storage capacity and no net increase in flood stage or velocities will result. Floodplain habitat will be restored, to the extent practicable.	
Wetlands, Aquatic Ecosystem	Clean Water Act (CWA) Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material	33 USC § 1344(b)(1); 40 CFR Parts 230 & 231; and 33 CFR Parts 320-323	Applicable	For discharge of dredged or fill material into water bodies or wetlands, there must be no practicable alternative with less adverse impact on aquatic ecosystem; discharge cannot cause or contribute to violation of state water quality standards or toxic effluent standards or jeopardize threatened or endangered species; discharge cannot significantly degrade waters of U.S.; practicable steps must be taken to minimize and mitigate adverse impacts; and impacts on flood level, flood velocity, and flood storage capacity must be evaluated. Sets standards for restoration and mitigation required as a result of unavoidable impacts to aquatic resources. USEPA must determine which alternative is the "Least Environmentally Damaging Practicable Alternative" (LEDPA) to protect wetland and aquatic resources.	Remedial alternatives will be developed and designed to comply with these regulations. Compensatory wetlands mitigation will need to be performed as necessary to comply with this ARAR. The selected alternative will need to be determined to be the least environmentally damaging practicable alternative that meets the remedial action objectives.	No action, therefore not applicable.	Under these alternatives, the remedial activities may impact federal jurisdictional wetlands. The remedial activities will be conducted in accordance with these requirements including, but not limited to, appropriate avoidance, minimization, mitigation and restoration.		
Wetlands	U.S. Army Corps of Engineers, New England District Compensatory Mitigation Guidance (09-07-2016)	New England District Compensatory Mitigation Guidance (09-07-2016)	To Be Considered	This Guidance is to be considered when compensatory mitigation to address impacts to federal jurisdiction wetlands is appropriate for a particular remedial activity.	Activities affecting federal jurisdictional wetlands will be conducted in accordance with these guidance standards for mitigation and restoration.	No action, therefore not applicable.	Under these alternatives, the remedial activities may impact federal jurisdictional wetlands. Activities affecting federal jurisdictional wetlands will be conducted in accordance with these guidance standards for mitigation and/or restoration.		
Surface Waters, Wetland/Waterway Habitat for Endangered Species, Migratory Species	Fish and Wildlife Coordination Act	16 USC § 661 et seq. 40 CFR § 6.302(g)	Applicable	Requires that any federal agency proposing to modify a body of water must consult with the U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service, and other related state agencies. That federal agency must consult with the appropriate government entities and also take action to prevent, mitigate, or compensate for project-related losses of or damage to endangered species, fish and wildlife resources.	All appropriate state and federal agencies, such as the USFWS, will be consulted to ensure that losses of or damage to habitat and wildlife will be prevented, mitigated, or compensated to the extent necessary.	No action, therefore not applicable.	Consultation with appropriate federal and state agencies will be maintained during planning and implementation of any remedial work that impacts wetlands or water bodies to ensure that losses of or damage to habitat and wildlife will be prevented, mitigated, or compensated.		

Table 2.1-4
Location-Specific ARARs, Criteria, Advisories, and Guidance; Upland Soil
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement	Upland Soil Alternatives			
						Soil 1 - No Action	Soil 2 - Cover System	Soil 3 - Excavation (0-1 ft) and Cover Systems	Soil 4 - Excavation (0-10 ft) and Off Site Disposal
Endangered Species	Endangered Species Act	16 U.S.C. §§ 1531 et seq.; 50 CFR §§ 17.11-17.12; 50 CFR Part 402	Applicable, if endangered species are encountered	This act requires action to avoid jeopardizing the continued existence of listed endangered or threatened species or modification of their habitat.	No known endangered species have been identified in the vicinity of the OCSS. However, protection of endangered species and their habitat will be considered during development and design of remedial alternatives.	No action, therefore not applicable.	No endangered or threatened species have been identified at the Site to date. If endangered or threatened species in the remedial area are identified, remedial activities would avoid actions that adversely affect endangered or threatened species or their habitats.		
Historical/ Archeological Resources	National Historic Preservation Act	54 USC §§ 300101 et seq., 36 CFR Part 800	Applicable, if subject historical resources are present	When a federal agency finds, or is notified, that its activities may have adverse effects on historic properties, such agency is required to consult with federal and state historic preservation officials to resolve the adverse effects, including avoidance, minimization, or mitigation of the adverse effects.	If protected resources are identified in the Site area, measures to avoid, minimize and/or mitigate any adverse effects to protected resources will be implemented in consultation with federal and state historic preservation officials.	No action, therefore not applicable.	If protected resource areas are identified in the remedial area, measures to avoid, minimize and/or mitigate any impacts to protected resource areas will be implemented in consultation with federal and state historic preservation officials.		
Atlantic Flyway	Migratory Bird Treaty Act	16 USC § 703 et seq.	Applicable, if subject protected species are present	Protects migratory birds, their nests and eggs. A depredation permit issued by the U.S. Fish and Wildlife Service (USFWS) is required to take, possess, or transport migratory birds or disturb their nests, eggs, or young.	Remedial activities will be evaluated to protect migratory birds, their nests and eggs. If migratory bird protected areas are identified in the site area, measures to avoid, minimize and/or mitigate any impacts to protected resource areas will be implemented in consultation with appropriate USFWS officials.	No action, therefore not applicable.	If migratory bird protected areas are identified within the remedial area, measures to avoid, minimize and/or mitigate any impacts to protected resource areas will be implemented in consultation with appropriate USFWS officials.		
State Standards									
Endangered Species	Massachusetts Endangered Species Regulations	321 CMR 10.00	Applicable, if endangered species are encountered	Requires action to regulate the impact to state listed endangered or threatened species or their habitats. Actions must be conducted in a manner that minimizes the impact to Massachusetts-listed rare, threatened, or endangered species, and species listed by the Massachusetts Natural Heritage Program.	No known endangered species have been identified in the vicinity of the Site. However, if identified, protection of state listed endangered species and their habitat will be considered during design and implementation of remedial alternatives.	No action, therefore not applicable.	No endangered or threatened species have been identified at the Site to date. If state listed endangered or threatened species in the site area are identified, remedial activities would avoid actions that adversely affect endangered or threatened species or their habitats.		
Historical/ Archeological Resources	Massachusetts Antiquities Act; Massachusetts Historical Commission Regulations; Protection of Properties Included in the State Register of Historic Places	MGL c. 9, §§ 26-27C; 950 CMR 70.00 and 71.00	Applicable, if subject historical resources are present.	Projects must eliminate, limit, or mitigate adverse effects to properties listed in the State Register of Historic Places (historic and archaeological properties). Establishes coordination with the National Historic Preservation Act.	If protected resources are identified in the Site area, measures to avoid, minimize and/or mitigate any impacts to protected resources will be implemented in consultation with federal and state historic preservation officials.	No action, therefore not applicable.	If protected resource areas are identified in the remedial area, measures to avoid, minimize and/or mitigate any impacts to protected resource areas will be implemented in consultation with federal and state historic preservation officials.		
Area of Critical Environmental Concern	Massachusetts Areas of Critical Environmental Concern (ACECs) Regulations	310 CMR 12.00	Applicable, if ACEC is identified	An ACEC is of regional, state, or national importance or contains significant ecological systems with critical interrelationships among a number of components. An eligible area must contain features from four or more of the following groups: (1) fisheries, (2) coastal features, (3) estuarine wetlands, (4) inland wetlands, (5) inland surface waters, (6) water supply areas (e.g., aquifer recharge area); (7) natural hazard areas (e.g., floodplain); (8) agricultural areas; (9) historical/archeological resources; (10) habitat resources (e.g., for endangered wildlife); or (11) special use areas. After an area is designated as an ACEC, the aim is to preserve and restore these areas.	No known ACECs have been identified at the Site. If an ACEC is identified in the Site area, activities will be controlled to minimize impacts to affected species or resources if identified.	No action, therefore not applicable.	No known ACECs have been identified at the site. If an ACEC is identified in the remediation area, remedial activities will be controlled to minimize impacts to affected species or resources.		

Table 2.1-4
Location-Specific ARARs, Criteria, Advisories, and Guidance; Upland Soil
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement	Upland Soil Alternatives			
						Soil 1 - No Action	Soil 2 - Cover System	Soil 3 - Excavation (0-1 ft) and Cover Systems	Soil 4 - Excavation (0-10 ft) and Off Site Disposal
Floodplains, Wetlands, Surface Waters	Massachusetts Wetland Protection Act and Regulations	MGL c. 131, § 40; 310 CMR 10.00	Applicable if alternative alters wetlands or floodplains	These regulations restrict dredging, filling, altering, or polluting inland wetland resource areas (defined as areas within the 100-year floodplain) and buffer zones (100 feet of a vegetated wetland or 200 feet from a perennial stream), and impose performance standards for work in such areas. Protected resource areas include: 10.54 (Bank); 10.55 (Bordering Vegetated Wetlands); 10.56 (Land under Water Bodies and Waterways); 10.57 (Land Subject to Flooding); and 10.58 (Riverfront Area).	Any remedial activity conducted within 100 feet of a state regulated wetland resource area or 200 feet from a perennial stream will comply with the substantive requirements of these regulations. Mitigation of impacts on state wetland resource areas will be addressed.	No action, therefore not applicable.	S2 - This alternative includes the use of soil covers in/adjacent to wetlands and floodplains and will comply with this ARAR through appropriate avoidance, minimization, mitigation and restoration. Wetlands altered by soil covers installed adjacent to such wetlands will be restored in place. Floodplain habitat will be restored, to the extent practicable. Any remedial activity to be performed within wetlands and the 100 foot buffer zone or 200 feet from a perennial stream will be in accordance with the substantive requirements of these regulations. S3/S4- These alternatives include excavation and restoration in/adjacent to wetlands and floodplains and will comply with this ARAR through appropriate avoidance, minimization, mitigation and restoration. No net loss of flood storage capacity and no net increase in flood stage or velocities will result. Floodplain habitat will be restored, to the extent practicable. Any remedial activity to be performed within wetlands and the 100 foot buffer zone or 200 feet from a perennial stream will be in accordance with the substantive requirements of these regulations.		
Wetlands, Aquatic Ecosystem	Massachusetts Clean Water Act; Massachusetts Water Quality Certification for Discharge of Dredged or Fill Material	MGL c. 21, §§ 26-53; 314 CMR 9.00	Applicable, if alternative involves filling of wetlands	For discharges of dredged or fill material, there must be no practicable alternative with less adverse impact on the aquatic ecosystem; appropriate and practicable steps must be taken to avoid and minimize potential adverse impacts to wetlands and land under water; stormwater discharges must be controlled with BMPs; and there must not be substantial adverse impacts to the physical, chemical, or biological integrity of surface waters. For dredging and dredged material management, there must be no practicable alternative with less adverse impact on the aquatic ecosystem; and if avoidance is not possible, then minimize, or if neither avoidance or minimization are possible, then mitigate potential adverse impacts	The remedial alternatives' effects on the aquatic ecosystem will be evaluated and avoided, and/or minimized. Compensatory mitigation will need to be performed as necessary to comply with this ARAR. The selected alternative will need to be determined to be the least environmentally damaging practicable alternative that meets the remedial action objectives. Any required removal of soil/sediment from wetland or surface water areas will be designated for eventual restoration. Excavation and filling activities to be performed impacting the aquatic ecosystem will be in accordance with the substantive requirements of these regulations	No action, therefore not applicable.	Under these alternatives, remedial activities will occur in/adjacent to wetlands and floodplains and will comply with this ARAR so as to not impair surface water quality		

Prepared By / Date: JW 02/05/2020
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Notes:
ACEC = Areas of Critical Environmental Concern
ARAR = Applicable or Relevant and Appropriate Requirement
CFR = Code of Federal Regulations
CMR = Code of Massachusetts Regulations

Table 2.1-5
Chemical-Specific ARARs, Criteria, Advisories, and Guidance; Upland Soil
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement	Upland Soil Alternatives			
					Soil 1 - No Action	Soil 2 - Cover System	Soil 3 - Excavation (0-1 ft) and Cover Systems	Soil 4 - Excavation (0-10 ft) and Off-Site Disposal
Federal Standards								
USEPA Risk Reference Doses (RfDs)	USEPA RfDs	To Be Considered	RfDs are considered to be the levels unlikely to cause significant adverse non-cancer health effects associated with a threshold mechanism of action in human exposure for a lifetime. Used in developing risk-based cleanup standards by computing human health hazard resulting from exposure to non-carcinogens at the Site.	RfDs were considered during development of PRGs.	Not applicable	Were considered in development of PRGs.		
USEPA Carcinogenic Assessment Group, Cancer Slope Factors (CSFs)	USEPA CSFs	To Be Considered	CSFs are estimates of the upper-bound probability on the increased cancer risk from a lifetime exposure to contaminants. Used in developing risk-based cleanup standards by computing the incremental cancer risk from exposure to contaminants at the Site.	CSFs were considered during development of PRGs.	Not applicable	Were considered in development of PRGs.		
Guidelines for Carcinogenic Risk Assessment	EPA/630/P-03/001F, March 2005	To Be Considered	These guidance values are to be used to evaluate the potential carcinogenic hazard caused by exposure to contaminants.	These guidelines were considered during development of PRGs.	Not applicable	Were considered in development of PRGs.		
Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens	EPA/630/R-03/003F, March 2005	To Be Considered	These guidance values are to be used to evaluate the potential carcinogenic hazard to children caused by exposure to contaminants.	These guidelines were considered during development of PRGs.	Not applicable	Were considered in development of PRGs.		
Regional Screening Levels for Chemical Contaminants at Superfund Sites	USEPA Regional Screening Levels for Chemical Contaminants at Superfund Sites	To Be Considered	Regional Screening Levels (RSLs) are risk based tools for screening contaminants at Superfund sites. RSLs are not intended to be cleanup standards.	RSLs were used to assess health risks due to exposure to chemicals in soil and to develop soil PRGs. .	Not applicable	Were considered in development of PRGs.		
Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites	OSWER 9355.4-24 (2002)	To Be Considered	EPA guidance for evaluating soil contamination. Used to develop risk-based cleanup standards, including based on the leaching of soil contaminants to groundwater.	This guidance was used to assess health risks due to exposure to chemicals in soil and to develop soil PRGs.	Not applicable	Were considered in development of PRGs.		
Soil Screening Guidance: Technical Background Document	EPA/540/R95/128 (1996)	To Be Considered	EPA guidance for evaluating soil contamination. Used to develop risk-based cleanup standards.	This guidance was used to assess health risks due to exposure to chemicals in soil and to develop soil PRGs.	Not applicable	Were considered in development of PRGs.		

Table 2.1-5
Chemical-Specific ARARs, Criteria, Advisories, and Guidance; Upland Soil
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Olin Chemical Superfund Site
Wilmington, Massachusetts

Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement	Upland Soil Alternatives			
					Soil 1 - No Action	Soil 2 - Cover System	Soil 3 - Excavation (0-1 ft) and Cover Systems	Soil 4 - Excavation (0-10 ft) and Off-Site Disposal
Ecological Risk Assessment Guidance for Superfund	EPA/540/R97/006	To Be Considered	EPA guidance used to develop site-specific ecological risk-based cleanup standards.	This guidance was used to assess ecological risks due to exposure to chemicals in soil and to develop soil PRGs.	Not applicable	Were considered in development of PRGs.		
Ecological Soil Screening Levels (Eco-SSLs)	EPA, https://www.epa.gov/risk/ecological-soil-screening-level-eco-ssl-guidance-and-documents	To Be Considered	Provides nonregulatory soil screening criteria and toxicity reference values for the protection of ecological receptors.	The eco-SSLs provide ecological toxicity reference values which were considered in the development of soil PRGs.	Not applicable	Were considered in development of PRGs.		
	European Regulation on Registration, Evaluation, Authorisation, and Restriction of Chemicals (REACH) Dossier	https://echa.europa.eu/regulations/reach/substance-registration/the-registration-dossier	To Be Considered	Source of ecological soil screening benchmarks used to develop site-specific ecological risk-based cleanup standards.	Not applicable	Were considered in development of PRGs.		
	Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision. Oak	(Efroymson, Will & Suter, 1997) http://www.hsrd.ornl.gov/ecorisk/tm126r21.pdf	To Be Considered	Source of ecological soil screening benchmarks used to develop site-specific ecological risk-based cleanup standards.	Not applicable	Were considered in development of PRGs.		
	Ontario Ministry of the Environment. 2011. Rationale for the Development of Generic Soil and Ground Water Standards for Use at Contaminated Sites in Ontario	42 USC § 300f et seq.; 40 CFR Part 141, Subparts B and G	Relevant and Appropriate	These regulations establish MCLs for common organic and inorganic contaminants applicable to public drinking water supplies. MCLs are federally enforceable standards based in part on the availability and cost of treatment techniques.	Not applicable	Were considered in development of PRGs.		

Prepared By / Date: JW 02/05/2020
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Notes:
ARAR = Applicable or Relevant and Appropriate Requirement
CSF = cancer slope factor
OSWER = Office of Solid Waste and Emergency Response
PRGs = Preliminary Remediation Goals
RfD = reference dose
RSL = Regional Screening Level
USEPA = United States Environmental Protection Agency
eco-SSLs - Ecological Soil Screening Levels

Table 2.1-6
Action-Specific ARARs, Criteria, Advisories, and Guidance; Upland Soil
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement	Upland Soil Alternatives			
						Soil 1 - No Action	Soil 2 - Cover System	Soil 3 - Excavation (0-1 ft) and Cover Systems	Soil 4 - Excavation (0-10 ft) and Off-Site Disposal
Federal Standards									
Hazardous Waste Treatment, Storage, Disposal	Resource Conservation and Recovery Act (RCRA) Subtitle C; Hazardous Waste Identification; Generator and Handler Requirements; Tracking Requirements; Storage, Treatment and Disposal Requirements; Groundwater Monitoring Requirements; Closure and Post Closure Requirements	42 USC § 6901 et seq.; 40 CFR Parts 260-262, Part 264	Applicable, if hazardous waste is generated.	Federal standards used to identify, manage, and dispose of hazardous waste. Massachusetts has been delegated the authority to administer these RCRA standards through its state hazardous waste management regulations.	Any wastes generated during remedial activities will be analyzed under these standards to determine whether they are listed or characteristic hazardous waste. Non-hazardous wastes will be disposed of appropriately. Any waste generated during remedial activities that is determined to be hazardous waste will be managed in accordance with these regulations. Alternatives generating hazardous waste or using treatment, storage or disposal facilities for hazardous waste will be implemented to comply with this ARAR.	No action, therefore not applicable.	Not applicable, no hazardous waste will be generated as part of this alternative.	Excavated soil will be analyzed under these standards to determine whether it contains characteristic hazardous waste and will be managed in accordance with these regulations. Under this alternative, any generation, treatment, or storage of hazardous waste will comply with this ARAR through appropriate design implementation and operation.	
Hazardous Waste - Air Emissions	RCRA, Air Emission Standards for Process Vents; Equipment Leaks; Tanks, Surface Impoundments, and Containers	40 CFR Part 264, Subparts AA, BB, and CC	Applicable, if hazardous wastes: will be managed by process vents with volatile organic concentrations of at least 10 parts per million by weight (ppmw) (Subpart AA); will be managed by equipment with organic concentrations of at least 10% by weight (Subpart BB); or will be managed in tanks, surface impoundments, or containers, and thresholds are met (Subpart CC). Relevant and Appropriate, if organics less than thresholds or for non-hazardous waste. Relevant and Appropriate, if less than thresholds.	RCRA emissions standards not delegated to the State. Standards for process vents for systems that manage hazardous wastes that have organic concentrations of at least 10 ppmw. Standards for air equipment leaks for systems that manage hazardous wastes with organic concentrations of at least 10% by weight. Standards for tanks, surface impoundments, and containers that manage hazardous wastes with average VOC concentrations of 500 ppm by weight or greater.	Process vents, air equipment, tanks, surface impoundments or containers will be managed in accordance with these air emission regulations.	No action, therefore not applicable.	Not applicable, no hazardous waste will be generated as part of this alternative.	No waste generated in these remedial activities is expected to have concentrations over these thresholds. Management of VOCs in excavated soil would be in accordance with these air emission regulations.	
Air Emissions	Clean Air Act (CAA), Hazardous Air Pollutants; National Emission Standards for Hazardous Air Pollutants (NESHAPs)	42 USC § 112(b)(1); 40 CFR Part 61	Applicable	These regulations establish emissions standards for 189 hazardous air pollutants.	No air emissions from remedial activities, such as soil excavation, would cause air quality standards to be exceeded. Dust standards would be complied with during remedial activities.	No action, therefore not applicable.	These alternatives will comply with the ARAR by ensuring that air emission standards are not exceeded during remedial activities.		
Discharges to Surface Water; Storm Water Controls	Clean Water Act; National Pollutant Discharge Elimination System (NPDES)	40 CFR Parts 122 and 125	Applicable (and if surface water discharge occurs, discharge standards are also applicable)	These requirements include storm water standards for construction activities disturbing more than one acre and requirements for stormwater discharges from hazardous waste treatment, storage, and disposal facilities. These requirements also specify the permissible concentration or level of contaminants in the discharge from any point source to waters of the United States.	Best management practices will be used to control and manage stormwater runoff during construction and operation. Alternatives that incorporate discharges to surface waters will need to have the discharges meet the substantive discharge standards (the Massachusetts Surface Water Discharge Permit Program [314 CMR 3.00] has similar requirements).	No action, therefore not applicable.	Not applicable, no dewatering, treatment and/or discharge is required under these alternatives. Best management practices will be used to control and manage stormwater runoff during construction for the soil excavation and/or of the soil cover.		Excavation dewatering, treatment and discharge will likely be required. Any discharge to surface water will be treated to meet these standards. Best management practices will be used to control and manage stormwater runoff during construction for the soil excavation.
Discharge to a Publicly Owned Treatment Works (POTW)	General Pretreatment Regulations for Existing and New Sources of Pollution	40 CFR Part 403	Applicable, if discharge to a POTW occurs	Standards for discharge into a Publicly Owned Treatment Works (POTW).	If remedial activities result in discharges to a POTW, the discharge will be monitored and treated, if necessary, to comply with pretreatment standards.	No action, therefore not applicable.	Not applicable, no dewatering, treatment and/or discharge to a POTW is required under these alternatives.		Any water generated during soil excavation/ management and excavation dewatering discharged to a POTW will be treated to meet these standards.
Investigation-Derived Waste (IDW)	Guide to Management of Investigation-Derived Wastes	USEPA OSWER Publication 9345.3-03FS, January 1992	To Be Considered	Guidance on management of IDW in a manner that ensures protection of human health and the environment.	IDW generated as part of this remedial alternative will be managed based on guidance standards.	No action, therefore not applicable.	IDW generated as part of pre-design investigations for this remedy will by managed in compliance with this guidance.		
State Standards									
Hazardous Waste Identification	Massachusetts Hazardous Waste Management Rules for Identification and Listing of Hazardous Wastes	310 CMR 30.100	Applicable, if hazardous waste is generated	Massachusetts is delegated to administer RCRA through its state regulations. These regulations establish requirements for determining whether wastes are either listed or characteristic hazardous waste.	These Massachusetts regulations supplement federal RCRA requirements. Any wastes generated during remedial activities will be analyzed under these standards to determine whether they are listed or characteristic hazardous wastes. Hazardous and nonhazardous wastes will be managed and disposed of appropriately.	No action, therefore not applicable.	Not applicable, no hazardous waste will be generated as part of this alternative.	All soil that is excavated and determined to contain hazardous waste will be managed as a hazardous waste in accordance with these regulations.	

Table 2.1-6
Action-Specific ARARs, Criteria, Advisories, and Guidance; Upland Soil
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement	Upland Soil Alternatives			
						Soil 1 - No Action	Soil 2 - Cover System	Soil 3 - Excavation (0-1 ft) and Cover Systems	Soil 4 - Excavation (0-10 ft) and Off-Site Disposal
Hazardous Waste - Generator Standards	Massachusetts Hazardous Waste Rules – Requirements for Generators	310 CMR 30.300	Applicable, if hazardous waste is generated	These regulations contain requirements for hazardous waste generators. The regulations apply to generators of sampling waste and also apply to the accumulation of waste prior to off-site disposal.	If any remedial activity generates hazardous wastes, the wastes will be managed in accordance with the substantive requirements of these regulations.	No action, therefore not applicable.	Not applicable, no hazardous waste will be generated as part of this alternative.	Any hazardous waste generated by these remedial alternatives will comply with the ARAR through appropriate design, implementation and operation.	
Hazardous Waste - Management Facility Standards	Massachusetts Hazardous Waste Rules – Management Standards for All Hazardous Waste Facilities	310 CMR 30.500	Applicable, if hazardous waste is generated	General facility requirements for waste analysis, security measures, inspections, and training requirements. Section 30.580 addresses closure. Section 30.590 addresses post-closure of hazardous waste facilities. Section 30.513 requires a general waste analysis of any hazardous waste.	Any waste generated during remedial activities that is determined to be hazardous waste will be managed in accordance with these regulations. Alternatives generating hazardous waste or using treatment, storage or disposal facilities for hazardous waste will be implemented to comply with this ARAR.	No action, therefore not applicable.	Not applicable, no hazardous waste will be generated as part of this alternative.	Any hazardous waste generated by these remedial alternatives will comply with the ARAR through appropriate design and operation.	
Hazardous Waste - Groundwater	Massachusetts Hazardous Waste Rules – Groundwater Protection	310 CMR 30.660	Applicable, if hazardous waste is managed in a regulated unit	310 CMR 30.661 through 30.673 prescribe requirements for regulated units that receive hazardous waste, except for certain waste piles, to protect groundwater.	Any hazardous waste generated by the remedial alternative will be managed to prevent contaminant migration to groundwater.	No action, therefore not applicable.	Not applicable, no hazardous waste will be generated as part of this alternative.	Any hazardous waste generated by these remedial alternatives will comply with the ARAR through appropriate design, implementation and operation	
Hazardous Waste - Waste Piles	Massachusetts Hazardous Waste Rules – Waste Piles	310 CMR 30.640	Applicable, if hazardous waste is managed in waste piles	310 CMR 30.641 through 30.649 prescribe requirements for storage and treatment of hazardous waste in waste piles. Provides specifications for inter alia design and operations, monitoring and inspection, and closure and post-closure care.	Any hazardous wastes that may be generated during remedial activities will be managed in accordance with these regulations.	No action, therefore not applicable.	Not applicable, no hazardous waste will be generated as part of this alternative.	Any hazardous waste generated by these remedial alternatives will be evaluated to determine whether it is hazardous waste. Under this alternative, any management of hazardous waste in waste piles will comply with in this ARAR through appropriate design, implementation and operation	
Hazardous Waste - Containers	Massachusetts Hazardous Waste Rules – Use and Management of Containers	310 CMR 30.680	Applicable, if hazardous waste is containerized	310 CMR 30.681 through 30.689 prescribe requirements for the use of containers, such as drums, to store hazardous waste. Provides specifications for inter alia labelling and marking, management of containers, inspections, and closure.	Establishes requirements for the management of containers, such as drums, that are used to store hazardous wastes. Alternatives utilizing containers of hazardous waste will comply with this ARAR.	No action, therefore not applicable.	Not applicable, no hazardous waste will be generated as part of this alternative.	Any hazardous waste generated by these remedial alternatives that is managed in containers will comply with the ARAR through appropriate design and implementation.	
Hazardous Waste - Tanks	Massachusetts Hazardous Waste Rules – Storage and Treatment in Tanks	310 CMR 30.690	Applicable, if hazardous waste is stored and/or transported in tanks	310 CMR 30.691 through 30.699 prescribe requirements for the use of tanks to store and treat hazardous waste. Provides specifications for inter alia design and installation, containment and detection of leaks, general operating requirements, inspections, and closure and post-closure care.	Alternatives utilizing tanks for storage or treatment of hazardous waste will comply with this ARAR.	No action, therefore not applicable.	Not applicable, no hazardous waste will be generated as part of this alternative.	Any hazardous waste generated by this remedial alternative that is managed in tanks will comply with the ARAR through appropriate design and implementation.	
Solid Waste	Massachusetts Solid Waste Management Regulations	310 CMR 19.000	Applicable, if solid waste is generated	This regulation establishes requirements for the storage, transfer, processing, treatment, disposal, use and reuse of solid waste (including asbestos), including contracting for disposal or transport of solid waste.	Any wastes generated by remedial activity that are determined to not be hazardous wastes will be managed in accordance with this regulation .	No action, therefore not applicable.	Not applicable, no solid waste will be generated as part of this alternative.	Any solid waste generated by these remedial alternatives will comply with the ARAR through appropriate design and implementation.	
Air Emissions	Massachusetts Air Pollution Control Regulations	310 CMR 7.00	Applicable	These regulations set emission limits necessary to attain ambient air quality standards including standards for visible emissions (7.06); dust, odor, construction and demolition (7.09); noise (7.10); and asbestos (7.15).	Remedial activities will be implemented in accordance with these rules. No air emissions from remedial activities will cause air quality standards to be exceeded.	No action, therefore not applicable.	These alternatives will comply with the ARAR by ensuring that air emissions are not exceeded during remedial activities.		

Table 2.1-6
Action-Specific ARARs, Criteria, Advisories, and Guidance; Upland Soil
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Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement	Upland Soil Alternatives			
						Soil 1 - No Action	Soil 2 - Cover System	Soil 3 - Excavation (0-1 ft) and Cover Systems	Soil 4 - Excavation (0-10 ft) and Off-Site Disposal
Discharges to Surface Waters	Massachusetts Clean Water Act; Surface Water Discharge Permit Regulations	MGL c. 21, §§ 26-53; 314 CMR 3.00	Applicable, if surface water discharge occurs	These regulations require that discharges to waters of the Commonwealth shall not result in exceedances of Massachusetts Surface Water Quality Standards (MSWQS) (314 CMR 4.00).	Any water discharged to surface waters related to excavation and dewatering activities will be treated to meet the substantive discharge standards of the Massachusetts Surface Water Discharge Permit (314 CMR 4.00).	No action, therefore not applicable.	Not applicable, no dewatering, treatment and/or discharge is required under this alternative.		Excavation dewatering, treatment and discharge will likely be required. Any discharge to surface water will be treated to meet these standards.
Discharges to Surface Water	Massachusetts Clean Water Act; MA Surface Water Quality Standards (MSWQS)	M.G.L. c. 21, §§ 26-53; 314 CMR 4.00	Applicable, if surface water discharge occurs	These standards designate the most sensitive uses for which the various waters of the Commonwealth shall be enhanced, maintained, or protected. Minimum water quality criteria required to sustain the designated uses are established.	Alternatives that incorporate discharges to surface waters will need to have the discharges meet the MSWQS.	No action, therefore not applicable.	Not applicable, no dewatering, treatment and/or discharge is required under this alternative.		Any discharge to surface water from soil excavation/ management and excavation dewatering will be treated to meet these standards.
Discharge to Publicly Owned Treatment Works (POTW)	Massachusetts Operation, Maintenance and Pretreatment Standards for Wastewater Treatment Works and Indirect Dischargers	314 CMR 12.00	Applicable, if discharges to a POTW occur	Standards for pretreatment requirements for sources to a POTW.	If remedial actions result in discharges to a POTW, the discharge will be monitored and treated, if necessary, to comply with pretreatment standards.	No action, therefore not applicable.	Not applicable, no dewatering, treatment and/or discharge is required under this alternative.		Any water discharged to a POTW during soil excavation/ management and excavation dewatering will be treated, if necessary, to meet these standards.
Hazardous Waste - Facility Discharge Standards	Massachusetts Supplemental Requirements for Hazardous Waste Management Facilities	MGL c. 21, §§ 26-53; 314 CMR 8.00	Applicable, if hazardous waste is generated and surface water discharge occurs	This regulation establishes additional requirements that must be satisfied for a RCRA facility (a wastewater treatment works which manages hazardous waste) that has a wastewater discharge permit.	Alternatives that involve management of hazardous waste prior to discharge to surface waters will meet the substantive standards.	No action, therefore not applicable.	Not applicable, no dewatering, treatment and/or discharge is required under this alternative.		Any management/treatment of dewatering liquid that is a hazardous waste prior to discharge to surface water will comply with the substantive standards
Hazardous Waste - Wastewater Treatment	Massachusetts Hazardous Waste Rules – Special Requirements for Wastewater Treatment Units	310 CMR 30.605	Applicable, if hazardous waste is managed in a WWTU	This regulation establishes standards for wastewater treatment units [WWTUs) for the treatment of hazardous waste	Any waste generated during remedial activities that is determined to be hazardous waste will be managed in accordance with these regulations, if applicable. Alternatives treating hazardous waste in tanks prior to discharge to surface water or a POTW will be implemented to comply with this ARAR.	No action, therefore not applicable.	Not applicable, no dewatering, treatment and/or discharge is required under this alternative.		Any management/treatment of dewatering liquid that is a hazardous waste prior to discharge to surface water or a POTW will comply with the substantive standards.
Sediment/Erosion Control; Stormwater Management	Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas	Prepared for Massachusetts Executive Office of Environmental Affairs (original print March 1997; reprint May 2003)	To Be Considered	Guidance on preventing erosion and sedimentation.	Remedial activities will be managed to control erosion and sedimentation.	No action, therefore not applicable.	These alternatives will be designed and managed to control erosion and sedimentation in accordance with this guidance.		
Monitoring Wells	Massachusetts Standard References for Monitoring Wells	WSC-310-91	To Be Considered	Guidance on locating, drilling, installing, sampling and decommissioning monitoring wells	Monitoring wells will be installed, maintained and decommissioned based on these guidance standards.	No action, therefore not applicable.	Monitoring wells that are required as part of these alternatives would be installed, maintained or decommissioned in accordance with this guidance.		
Air Quality	Division of Air Quality Control (DAQC)	DAQC Policy 90-001, re: Noise Regulation,	To Be Considered	Guidance on sound emissions.	The guidance will be used to assess whether any remedial measure exceed Stae noise guidance levels.	No action, therefore not applicable.	These alternatives will comply with the ARAR to assess whether any remedial measures exceed State noise guidance levels, and will follow the suggested noise limit to the extent possible in accordance with this guidance. Construction will be scheduled during daylight hours.		

Prepared By / Date: JW 02/05/2020
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Notes:
ARAR = Applicable or Relevant and Appropriate Requirement
CAA = Clean Air Act
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
CFR = Code of Federal Regulations
CMR = Code of Massachusetts Regulations
IDW = Investigation Derived Waste
MGL = Massachusetts General Law
MSWQS = Massachusetts Surface Water Quality Standards
NESHAP = National Emission Standards for Hazardous Air Pollutant
NPDES = National Pollutant Discharge Elimination System
OSWER = Office of Solid Waste and Emergency Response
ppmw = parts per million by weight
RCRA = Resource Conservation and Recovery Act
USC = United States Code
USEPA = United States Environmental Protection Agency

Table 2.1-7
Location-Specific ARARs, Criteria, Advisories, and Guidance; Sediment and Wetland Soil
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement	Wetland Soil and Sediment Alternatives	
						WSS 1 - No Action	WSS 2 - Excavation, Stabilization, and Off-Site Disposal
Federal Standards							
Floodplains and Wetlands	Floodplain Management and Protection of Wetlands	44 CFR Part 9 (implementing Executive Orders 11988 and 11990)	Applicable	Federal Emergency Management Agency (FEMA) regulations set forth the policy, procedure, and responsibilities to implement and enforce Executive Order 11988 (Floodplain Management) and Executive Order 11990 (Protection of Wetlands). These regulations prohibit activities that adversely affect a federally-regulated wetland unless there is no practicable alternative and the proposed action includes all practicable measures to minimize harm to wetlands that may result from such use. These regulations require the avoidance of impacts associated with the occupancy and modification of federally-designated 100-year and 500-year floodplains and require the avoidance of development within a floodplain wherever there is a practicable alternative. An assessment of impacts to the 500-year floodplain is required for critical actions, which includes siting waste facilities in a floodplain. These regulations require public notice when proposing any action in or affecting floodplains or wetlands.	If there is no practicable alternative method to work in federal jurisdictional wetlands, or 100-year or 500-year floodplains, then all practicable measures will be taken to minimize and mitigate any adverse impacts. Erosion and sedimentation control measures will be adopted during remedial activities to protect these wetlands and floodplains. Standards for excavating and managing contaminated soil, sediment, and groundwater/DAPL, etc. within the 100-year and 500-year floodplains will be attained. After completion of work, there will be no significant net loss of flood storage capacity and no significant net increase in flood stage or velocities. Floodplain habitat will be restored to the extent practicable. Public comment will be solicited as part of the Proposed Plan concerning any proposed alteration to wetlands and floodplains.	No action, therefore not applicable.	This alternative includes excavation and restoration in/adjacent to wetlands and floodplains and will comply with this ARAR through appropriate avoidance, minimization, mitigation and restoration. All remedial work within any regulated floodplain will result in no net loss of flood storage capacity and no net increase in flood stage or velocities. Floodplain habitat will be restored, to the extent practicable.
Floodplains	RCRA Floodplain Restrictions for Hazardous Waste Facilities	42 USC § 6901 et seq.; 40 CFR § 264.18(b)	Applicable, if hazardous waste is managed within the 100-year floodplain	A hazardous waste treatment, storage, or disposal facility located in a 100-year floodplain must be designed, constructed, operated, and maintained to prevent washout or to result in no adverse effects on human health or the environment if washout were to occur.	Any hazardous waste generated during remedial activities will be managed so that it will not impact floodplain resources.	No action, therefore not applicable.	Hazardous waste is not expected to be managed in a 100-year floodplain under this alternative. Any hazardous waste generated during these remedial activities will be managed so that it will not impact the floodplain resources.

Table 2.1-7
Location-Specific ARARs, Criteria, Advisories, and Guidance; Sediment and Wetland Soil
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement	Wetland Soil and Sediment Alternatives	
						WSS 1 - No Action	WSS 2 - Excavation, Stabilization, and Off-Site Disposal
Floodplains	RCRA Floodplain Restrictions for Solid Waste Disposal Facilities and Practices	40 CFR § 257.3-1	Applicable, if solid waste is managed within the 100-year floodplain	Solid waste practices must not restrict the flow of a 100-year flood, reduce the temporary water storage capacity of the floodplain, or result in washout of solid waste, so as to pose a hazard to human life, wildlife, or land or water resources.	Any solid waste generated from remedial activities involving excavation activities will be managed so that it will not impact floodplain resources.	No action, therefore not applicable.	Solid waste is not expected to be managed in a 100-year floodplain under this alternative. Any solid waste generated during these remedial activities will be managed so that it will not impact the floodplain resources.
Wetlands, Aquatic Ecosystem	Clean Water Act (CWA) Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material	33 USC § 1344(b)(1); 40 CFR Parts 230 & 231; and 33 CFR Parts 320-323	Applicable	For discharge of dredged or fill material into water bodies or wetlands, there must be no practicable alternative with less adverse impact on aquatic ecosystem; discharge cannot cause or contribute to violation of state water quality standards or toxic effluent standards or jeopardize threatened or endangered species; discharge cannot significantly degrade waters of U.S.; practicable steps must be taken to minimize and mitigate adverse impacts; and impacts on flood level, flood velocity, and flood storage capacity must be evaluated. Sets standards for restoration and mitigation required as a result of unavoidable impacts to aquatic resources. USEPA must determine which alternative is the "Least Environmentally Damaging Practicable Alternative" (LEDPA) to protect wetland and aquatic resources.	Remedial alternatives will be developed and designed to comply with these regulations. Compensatory wetlands mitigation will need to be performed as necessary to comply with this ARAR. The selected alternative will need to be determined to be the least environmentally damaging practicable alternative that meets the remedial action objectives.	No action, therefore not applicable.	Under this alternative, excavation/management of contaminated soil and sediment will impact federal jurisdictional water bodies and wetlands. The remedial activities will be conducted in accordance with these requirements including, but not limited to, appropriate avoidance, minimization, mitigation and restoration.
Wetlands	U.S. Army Corps of Engineers, New England District Compensatory Mitigation Guidance (09-07-2016)	New England District Compensatory Mitigation Guidance (09-07-2016)	To Be Considered	This Guidance is to be considered when compensatory mitigation to address impacts to federal jurisdiction wetlands is appropriate for a particular remedial activity.	Activities affecting federal jurisdictional wetlands will be conducted in accordance with these guidance standards for mitigation and restoration.	No action, therefore not applicable.	This alternative includes excavation and restoration in/adjacent to wetlands and floodplains. Activities affecting federal jurisdictional wetlands will be conducted in accordance with these guidance standards for mitigation and/or restoration.
Surface Waters, Wetland/Waterway Habitat for Endangered Species, Migratory Species	Fish and Wildlife Coordination Act	16 USC § 661 et seq. 40 CFR § 6.302(g)	Applicable	Requires that any federal agency proposing to modify a body of water must consult with the U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service, and other related state agencies. That federal agency must consult with the appropriate government entities and also take action to prevent	All appropriate state and federal agencies, such as the USFWS, will be consulted to ensure that losses of or damage to habitat and wildlife will be prevented, mitigated, or compensated to the extent necessary.	No action, therefore not applicable.	Consultation with appropriate federal and state agencies will be maintained during planning and implementation of the remedial work to ensure that losses of or damage to habitat and wildlife will be prevented, mitigated, or compensated.

Table 2.1-7
Location-Specific ARARs, Criteria, Advisories, and Guidance; Sediment and Wetland Soil
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement	Wetland Soil and Sediment Alternatives	
						WSS 1 - No Action	WSS 2 - Excavation, Stabilization, and Off-Site Disposal
Endangered Species	Endangered Species Act	16 U.S.C. §§ 1531 et seq.; 50 CFR §§ 17.11-17.12; 50 CFR Part 402	Applicable, if endangered species are encountered	This act requires action to avoid jeopardizing the continued existence of listed endangered or threatened species or modification of their habitat.	No known endangered species have been identified in the vicinity of the OCSS. However, protection of endangered species and their habitat will be considered during development and design of remedial alternatives.	No action, therefore not applicable.	No endangered or threatened species have been identified at the Site to date. If endangered or threatened species in the remedial area are identified, remedial activities would avoid actions that adversely affect endangered or threatened species or their habitats.
Historical/ Archeological Resources	National Historic Preservation Act	54 USC §§ 300101 et seq., 36 CFR Part 800	Applicable, if subject historical resources are present	When a federal agency finds, or is notified, that its activities may have adverse effects on historic properties, such agency is required to consult with federal and state historic preservation officials to resolve the adverse effects, including avoidance, minimization, or mitigation of the adverse effects.	If protected resources are identified in the Site area, measures to avoid, minimize and/or mitigate any adverse effects to protected resources will be implemented in consultation with federal and state historic preservation officials.	No action, therefore not applicable.	If protected resource areas are identified in the remedial area, measures to avoid, minimize and/or mitigate any impacts to protected resource areas will be implemented in consultation with federal and state historic preservation officials.
Atlantic Flyway	Migratory Bird Treaty Act	16 USC § 703 et seq.	Applicable, if subject protected species are present	Protects migratory birds, their nests and eggs. A depredation permit issued by the U.S. Fish and Wildlife Service (USFWS) is required to take, possess, or transport migratory birds or disturb their nests, eggs, or young.	Remedial activities will be evaluated to protect migratory birds, their nests and eggs. If migratory bird protected areas are identified in the site area, measures to avoid, minimize and/or mitigate any impacts to protected resource areas will be implemented in consultation with appropriate USFWS officials.	No action, therefore not applicable.	If migratory bird protected areas are identified within the remedial area, measures to avoid, minimize and/or mitigate any impacts to protected resource areas will be implemented in consultation with appropriate USFWS officials.
State Standards							
Floodplains, Wetlands, Surface Waters	Massachusetts Wetland Protection Act and Regulations	MGL c. 131, § 40; 310 CMR 10.00	Applicable if alternative alters wetlands or floodplains	These regulations restrict dredging, filling, altering, or polluting inland wetland resource areas (defined as areas within the 100-year floodplain) and buffer zones (100 feet of a vegetated wetland or 200 feet from a perennial stream), and impose performance standards for work in such areas. Protected resource areas include: 10.54 (Bank); 10.55 (Bordering Vegetated Wetlands); 10.56 (Land under Water Bodies and Waterways); 10.57 (Land Subject to Flooding); and 10.58 (Riverfront Area).	Any remedial activity conducted within 100 feet of a state regulated wetland resource area or 200 feet from a perennial stream will comply with the substantive requirements of these regulations. Mitigation of impacts on state wetland resource areas will be addressed.	No action, therefore not applicable.	This alternative includes excavation and restoration in/adjacent to wetlands and floodplains and will comply with this ARAR through appropriate avoidance, minimization, mitigation and restoration. All remedial work within any regulated floodplain will result in no net loss of flood storage capacity and no net increase in flood stage or velocities. Floodplain habitat will be restored, to the extent practicable. Any remedial activity to be performed within wetlands and the 100-foot buffer zone or 200 feet from a perennial stream will be in accordance with the substantive requirements of these regulations.

Table 2.1-7
Location-Specific ARARs, Criteria, Advisories, and Guidance; Sediment and Wetland Soil
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement	Wetland Soil and Sediment Alternatives	
						WSS 1 - No Action	WSS 2 - Excavation, Stabilization, and Off-Site Disposal
Floodplains	Massachusetts Hazardous Waste Regulations, Location Standards for Land Subject to Flooding	310 CMR 30.701	Applicable, if hazardous waste is managed within a floodplain	This regulation sets forth criteria for siting hazardous waste facilities within land subject to flooding (as defined under the Massachusetts Wetland Protection Act standards). Any new or expanded hazardous waste storage or treatment facility (which only receives hazardous waste from on-site sources), the active portion of which is located within the boundary of land subject to flooding from the statistical 100-year frequency storm, shall be flood-proofed. Flood-proofing shall be designed, constructed, operated and maintained to prevent floodwaters from coming into contact with hazardous waste.	To the extent any hazardous waste is generated during the remedial activities, the wastes will be managed so that it will not impact floodplain resources.	No action, therefore not applicable.	Hazardous waste is not expected to be managed in a 100-year floodplain under this alternative. Any hazardous waste generated during these remedial activities will be managed so that it will not impact the floodplain resources.
Wetlands, Aquatic Ecosystem	Massachusetts Clean Water Act; Massachusetts Water Quality Certification for Discharge of Dredged or Fill Material	MGL c. 21, §§ 26-53; 314 CMR 9.00	Applicable, if alternative involves filling of wetlands	For discharges of dredged or fill material, there must be no practicable alternative with less adverse impact on the aquatic ecosystem; appropriate and practicable steps must be taken to avoid and minimize potential adverse impacts to wetlands and land under water; stormwater discharges must be controlled with BMPs; and there must not be substantial adverse impacts to the physical, chemical, or biological integrity of surface waters. For dredging and dredged material management, there must be no practicable alternative with less adverse impact on the aquatic ecosystem; and if avoidance is not possible, then minimize, or if neither avoidance or minimization are possible, then mitigate potential adverse impacts	The remedial alternatives' effects on the aquatic ecosystem will be evaluated and avoided, and/or minimized. Compensatory mitigation will need to be performed as necessary to comply with this ARAR. The selected alternative will need to be determined to be the least environmentally damaging practicable alternative that meets the remedial action objectives. Any required removal of soil/sediment from wetland or surface water areas will be designated for eventual restoration. Excavation and filling activities to be performed impacting the aquatic ecosystem will be in accordance with the substantive requirements of these regulations	No action, therefore not applicable.	Under this alternative dredging/filling of wetlands during wetland soil/sediment excavation/ management will be conducted so as to not impair surface water quality.
Endangered Species	Massachusetts Endangered Species Regulations	321 CMR 10.00	Applicable, if endangered species are encountered	Requires action to regulate the impact to state listed endangered or threatened species or their habitats. Actions must be conducted in a manner that minimizes the impact to Massachusetts-listed rare, threatened, or endangered species, and species listed by the Massachusetts Natural Heritage Program.	No known endangered species have been identified in the vicinity of the Site. However, if identified, protection of state listed endangered species and their habitat will be considered during design and implementation of remedial alternatives.	No action, therefore not applicable.	No endangered or threatened species have been identified at the Site to date. If state listed endangered or threatened species in the site area are identified, remedial activities would avoid actions that adversely affect endangered or threatened species or their habitats.

Table 2.1-7
Location-Specific ARARs, Criteria, Advisories, and Guidance; Sediment and Wetland Soil
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement	Wetland Soil and Sediment Alternatives	
						WSS 1 - No Action	WSS 2 - Excavation, Stabilization, and Off-Site Disposal
Historical/ Archeological Resources	Massachusetts Antiquities Act; Massachusetts Historical Commission Regulations; Protection of Properties Included in the State Register of Historic Places	MGL c. 9, §§ 26-27C; 950 CMR 70.00 and 71.00	Applicable, if subject historical resources are present.	Projects must eliminate, limit, or mitigate adverse effects to properties listed in the State Register of Historic Places (historic and archaeological properties). Establishes coordination with the National Historic Preservation Act.	If protected resources are identified in the Site area, measures to avoid, minimize and/or mitigate any impacts to protected resources will be implemented in consultation with federal and state historic preservation officials.	No action, therefore not applicable.	If protected resource areas are identified in the remedial area, measures to avoid, minimize and/or mitigate any impacts to protected resource areas will be implemented in consultation with federal and state historic preservation officials.
Area of Critical Environmental Concern	Massachusetts Areas of Critical Environmental Concern (ACECs) Regulations	310 CMR 12.00	Applicable, if ACEC is identified	An ACEC is of regional, state, or national importance or contains significant ecological systems with critical interrelationships among a number of components. An eligible area must contain features from four or more of the following groups: (1) fisheries, (2) coastal features, (3) estuarine wetlands, (4) inland wetlands, (5) inland surface waters, (6) water supply areas (e.g., aquifer recharge area); (7) natural hazard areas (e.g., floodplain); (8) agricultural areas; (9) historical/archeological resources; (10) habitat resources (e.g., for endangered wildlife); or (11) special use areas. After an area is designated as an ACEC, the aim is to preserve and restore these areas.	No known ACECs have been identified at the Site. If an ACEC is identified in the Site area, activities will be controlled to minimize impacts to affected species or resources if identified.	No action, therefore not applicable.	No known ACECs have been identified at the site. If an ACEC is identified in the remediation area, remedial activities will be controlled to minimize impacts to affected species or resources.

Prepared By / Date: JD 03/10/2020
Checked By / Date: JW 03/19/2020

Notes:
ACEC = Areas of Critical Environmental Concern
ARAR = Applicable or Relevant and Appropriate Requirement
BMP = Best Management Practice
CFR = Code of Federal Regulations
CMR = Code of Massachusetts Regulations
CWA = Clean Water Act
DAPL = Dense Aqueous Phase Liquid
FEMA = Federal Emergency Management Agency
LEDPA = Least Environmentally Damaging Practicable Alternative
MGL = Massachusetts General Law
RCRA = Resource Conservation and Recovery Act
USEPA = United States Environmental Protection Agency
USFWS = United States Fish and Wildlife Service
USC = United States Code
WSS = Wetland Soil and Sediment

Table 2.1-8
Chemical-Specific ARARs, Criteria, Advisories, and Guidance; Sediment and Wetland Soil
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement	Wetland Soil and Sediment Alternatives	
						WSS 1 - No Action	WSS 2 - Excavation, Stabilization, and Off-Site Disposal
Federal Standards							
	Ecological Risk Assessment Guidance for Superfund	EPA/540/R97/006	To Be Considered	EPA guidance used to develop site-specific ecological risk-based cleanup standards.	This guidance was used to assess ecological risks due to exposure to chemicals in soil and to develop soil PRGs.	Not applicable	Were considered in development of PRGs.
	Ontario Ministry of Environment and Energy (OMEE) Severe Effect Levels (SELs) for Freshwater Sediments	(Persaud et al., 1993)	To Be Considered	The SEL value is the concentration at which the majority of the sediment-dwelling organisms are affected. Used to develop risk-based cleanup standards.	SELs were used to assess ecological risks due to exposure to chemicals in sediment and to develop sediment PRGs.	Not applicable	Were considered in development of PRGs.
	Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems. Probable Effects Concentrations (PECs)	(MacDonald et al., 2000)	To Be Considered	The PEC value is the concentration above which the adverse effects on sediment-dwelling organisms are likely to occur. Used to develop risk-based cleanup standards.	PECs were used to assess ecological risks due to exposure to chemicals in sediment and to develop sediment PRGs.	Not applicable	Were considered in development of PRGs.
	European Regulation on Registration, Evaluation, Authorisation, and Restriction of Chemicals (REACH) Dossier	https://echa.europa.eu/regulations/reach/substance-registration/the-registration-dossier	To Be Considered	Source of ecological soil screening benchmarks used to develop site-specific ecological risk-based cleanup standards.	This guidance was used to to develop soil PRGs.	Not applicable	Were considered in development of PRGs.
	Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision. Oak Ridge National Laboratory, Oak Ridge, TN. ES/ER/TM-126/R2.)	(Efroymson, Will & Suter, 1997) http://www.hsrd.ornl.gov/ecorisk/tm126r21.pdf	To Be Considered	Source of ecological soil screening benchmarks used to develop site-specific ecological risk-based cleanup standards.	This guidance was used to to develop soil PRGs.	Not applicable	Were considered in development of PRGs.
	Ontario Ministry of the Environment. 2011. Rationale for the Development of Generic Soil and Ground Water Standards for Use at Contaminated Sites in Ontario.	https://www.ontario.ca/page/soil-ground-water-and-sediment-standards-use-under-part-xv1-environmental-protection-act	To Be Considered	Source of ecological soil screening benchmarks used to develop site-specific ecological risk-based cleanup standards.	This guidance was used to develop soil PRGs.	Not applicable	Were considered in development of PRGs.

Prepared By / Date: JD 03/10/2020
Checked By / Date: JW 03/19/2020

Notes:
ARAR = Applicable or Relevant and Appropriate Requirement
OMEG = Ontario Ministry of Environment and Energy
PEC = Probable Effects Concentration
PRGs = Preliminary Remediation Goals
SEL - Severe Effect Level
WSS = Wetland Soil and Sediment

Table 2.1-9
Action-Specific ARARs, Criteria, Advisories, and Guidance; Sediment and Wetland Soil
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement	Wetland Soil and Sediment Alternatives	
						WSS 1 - No Action	WSS 1 - Excavation, Stabilization, and Off-Site Disposal
Federal Standards							
Hazardous Waste Treatment, Storage, Disposal	Resource Conservation and Recovery Act (RCRA) Subtitle C; Hazardous Waste Identification; Generator and Handler Requirements; Tracking Requirements; Storage, Treatment and Disposal Requirements; Groundwater Monitoring Requirements; Closure and Post Closure Requirements	42 USC § 6901 et seq.; 40 CFR Parts 260-262, Part 264	Applicable, if hazardous waste is generated.	Federal standards used to identify, manage, and dispose of hazardous waste. Massachusetts has been delegated the authority to administer these RCRA standards through its state hazardous waste management regulations.	Any wastes generated during remedial activities will be analyzed under these standards to determine whether they are listed or characteristic hazardous waste. Non-hazardous wastes will be disposed of appropriately. Any waste generated during remedial activities that is determined to be hazardous waste will be managed in accordance with these regulations. Alternatives generating hazardous waste or using treatment, storage or disposal facilities for hazardous waste will be implemented to comply with this ARAR.	No action, therefore not applicable.	No hazardous waste is expected to be generated by these remedial activities. Excavated soil will be analyzed under these standards to determine whether it contains listed or characteristic hazardous waste and will be managed in accordance with these regulations for off-site transportation and disposal. Under this alternative, any generation, treatment, or storage of hazardous waste will comply with this ARAR through appropriate design implementation and operation.
Hazardous Waste - Air Emissions	RCRA, Air Emission Standards for Process Vents; Equipment Leaks; Tanks, Surface Impoundments, and Containers	40 CFR Part 264, Subparts AA, BB, and CC	Applicable, if hazardous wastes: will be managed by process vents with volatile organic concentrations of at least 10 parts per million by weight (ppmw) (Subpart AA); will be managed by equipment with organic concentrations of at least 10% by weight (Subpart BB); or will be managed in tanks, surface impoundments, or containers, and thresholds are met (Subpart CC). Relevant and	RCRA emissions standards not delegated to the State. Standards for process vents for systems that manage hazardous wastes that have organic concentrations of at least 10 ppmw. Standards for air equipment leaks for systems that manage hazardous wastes with organic concentrations of at least 10% by weight. Standards for tanks, surface impoundments, and containers that manage hazardous wastes with average VOC concentrations of 500 ppm by weight or greater.	Process vents, air equipment, tanks, surface impoundments or containers will be managed in accordance with these air emission regulations.	No action, therefore not applicable.	No waste generated in this remedial alternative is expected to have concentrations over these thresholds. Management of VOCs in excavated soil and sediment would be in accordance with these air emission regulations
Discharges to Surface Water; Storm Water Controls	Clean Water Act; National Pollutant Discharge Elimination System (NPDES)	40 CFR Parts 122 and 125	Applicable (and if surface water discharge occurs, discharge standards are also applicable)	These requirements include storm water standards for construction activities disturbing more than one acre and requirements for stormwater discharges from hazardous waste treatment, storage, and disposal facilities. These requirements also specify the permissible concentration or level of contaminants in the discharge from any point source to waters of the United States	Best management practices will be used to control and manage stormwater runoff during construction and operation. Alternatives that incorporate discharges to surface waters will need to have the discharges meet the substantive discharge standards (the Massachusetts Surface Water Discharge Permit Program [314 CMR 3.00] has similar requirements).	No action, therefore not applicable.	Any discharge to surface water will be treated to meet these standards. Best management practices will be used to control and manage stormwater runoff during construction for the soil excavation.

Table 2.1-9
Action-Specific ARARs, Criteria, Advisories, and Guidance; Sediment and Wetland Soil
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement	Wetland Soil and Sediment Alternatives	
						WSS 1 - No Action	WSS 1 - Excavation, Stabilization, and Off-Site Disposal
Discharge to a Publicly Owned Treatment Works (POTW)	General Pretreatment Regulations for Existing and New Sources of Pollution	40 CFR Part 403	Applicable, if discharge to a POTW occurs.	Standards for discharge into a Publicly Owned Treatment Works (POTW).	If remedial actions result in discharges to a POTW, the discharge will be monitored and treated, if necessary, to comply with pretreatment standards.	No action, therefore not applicable.	Any water generated during soil excavation/ management and excavation dewatering will be treated to meet these standards, if the water is to be discharged to the POTW.
Air Emissions	Clean Air Act (CAA), Hazardous Air Pollutants; National Emission Standards for Hazardous Air Pollutants (NESHAPs)	42 USC § 112(b)(1); 40 CFR Part 61	Applicable	These regulations establish emissions standards for 189 hazardous air pollutants.	No air emissions from remedial activities, such as soil excavation, would cause air quality standards to be exceeded. Dust standards would be complied with during remedial activities.	No action, therefore not applicable.	This alternative will comply with the ARAR by ensuring that air emission standards are not exceeded during remedial activities.
Sediment Remediation	Contaminated Sediment Remediation Guidance for Hazardous Waste Sites	EPA-540-R-05-012; OSWER 9355.0-85 (December 2005)	To Be Considered	Guidance for making remedy decisions for contaminated sediment sites. Some of the relevant sections of the guidance address Remedial Investigations (Ch. 2), FS Considerations (Ch. 3), Monitored Natural Recovery (Ch. 4), In-Situ Capping (Ch. 5), and Dredging and Excavation (Ch. 6).	Remedial alternatives will be developed and implemented with consideration of this guidance.	No action, therefore not applicable.	Chromium- and/or BEHP-impacted wetland soil and sediments will be excavated in accordance with this guidance to a maximum depth of one foot bgs and disposed of off-site.
Investigation-Derived Waste (IDW)	Guide to Management of Investigation-Derived Wastes	USEPA OSWER Publication 9345.3-03FS, January 1992	To Be Considered	Guidance on management of IDW in a manner that ensures protection of human health and the environment.	IDW generated as part of this remedial alternative will be managed based on guidance standards.	No action, therefore not applicable.	IDW generated as part of pre-design investigations and excavation activities for this remedy will by managed in compliance with this guidance.

Table 2.1-9
Action-Specific ARARs, Criteria, Advisories, and Guidance; Sediment and Wetland Soil
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement	Wetland Soil and Sediment Alternatives	
						WSS 1 - No Action	WSS 1 - Excavation, Stabilization, and Off-Site Disposal
State Standards							
Hazardous Waste Identification	Massachusetts Hazardous Waste Management Rules for Identification and Listing of Hazardous Wastes	310 CMR 30.100	Applicable, if hazardous waste is generated	Massachusetts is delegated to administer RCRA through its state regulations. These regulations establish requirements for determining whether wastes are either listed or characteristic hazardous waste.	These Massachusetts regulations supplement federal RCRA requirements. Any wastes generated during remedial activities will be analyzed under these standards to determine whether they are listed or characteristic hazardous wastes. Hazardous and nonhazardous wastes will be managed and disposed of appropriately.	No action, therefore not applicable.	No hazardous waste is expected to be generated by these remedial activities. Any management of hazardous waste would be in accordance with these regulations.
Hazardous Waste - Generator Standards	Massachusetts Hazardous Waste Rules – Requirements for Generators	310 CMR 30.300	Applicable, if hazardous waste is generated	These regulations contain requirements for hazardous waste generators. The regulations apply to generators of sampling waste and also apply to the accumulation of waste prior to off-site disposal.	If any remedial activity generates hazardous wastes, the wastes will be managed in accordance with the substantive requirements of these regulations.	No action, therefore not applicable.	No hazardous waste is expected to be generated by these remedial activities. Any hazardous waste generated will comply with the ARAR through appropriate design, implementation and operation.
Hazardous Waste - Management Facility Standards	Massachusetts Hazardous Waste Rules – Management Standards for All Hazardous Waste Facilities	310 CMR 30.500	Applicable, if hazardous waste is generated	General facility requirements for waste analysis, security measures, inspections, and training requirements. Section 30.580 addresses closure. Section 30.590 addresses post-closure of hazardous waste facilities. Section 30.513 requires a general waste analysis of any hazardous waste.	Any waste generated during remedial activities that is determined to be hazardous waste will be managed in accordance with these regulations. Alternatives generating hazardous waste or using treatment, storage or disposal facilities for hazardous waste will be implemented to comply with this ARAR.	No action, therefore not applicable.	No hazardous waste is expected to be generated by these remedial activities. Any management of hazardous waste will comply with the ARAR through appropriate design, implementation and operation.
Hazardous Waste - Wastewater Treatment	Massachusetts Hazardous Waste Rules – Special Requirements for Wastewater Treatment Units	310 CMR 30.605	Applicable, if hazardous waste is managed in a WWTU	This regulation establishes standards for wastewater treatment units [WWTUs) for the treatment of hazardous waste	Any waste generated during remedial activities that is determined to be hazardous waste will be managed in accordance with these regulations, if applicable. Alternatives treating hazardous waste in tanks prior to discharge to surface water or a POTW will be implemented to comply with this ARAR.	No action, therefore not applicable.	No hazardous waste is expected to be generated by these remedial activities. Any management/treatment of hazardous waste will comply with the substantive standards.
Hazardous Waste - Groundwater	Massachusetts Hazardous Waste Rules – Groundwater Protection	310 CMR 30.660	Applicable, if hazardous waste is managed in a regulated unit	310 CMR 30.661 through 30.673 prescribe requirements for regulated units that receive hazardous waste, except for certain waste piles, to protect groundwater.	Any hazardous waste generated by the remedial alternative will be managed to prevent contaminant migration to groundwater.	No action, therefore not applicable.	No hazardous waste is expected to be generated by these remedial activities. Any hazardous waste managed in waste piles will comply with this ARAR through appropriate design and operation

Table 2.1-9
Action-Specific ARARs, Criteria, Advisories, and Guidance; Sediment and Wetland Soil
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement	Wetland Soil and Sediment Alternatives		
						WSS 1 - No Action	WSS 1 - Excavation, Stabilization, and Off-Site Disposal	
Hazardous Waste - Waste Piles	Massachusetts Hazardous Waste Rules – Waste Piles	310 CMR 30.640	Applicable, if hazardous waste is managed in waste piles	310 CMR 30.641 through 30.649 prescribe requirements for storage and treatment of hazardous waste in waste piles. Provides specifications for inter alia design and operations, monitoring and inspection, and closure and post-closure care.	Any hazardous wastes that may be generated during remedial activities will be managed in accordance with these regulations.	No action, therefore not applicable.	No hazardous waste is expected to be generated by these remedial activities. Any management of hazardous waste in waste piles will comply with this ARAR through appropriate design implementation and operation.	
Hazardous Waste - Containers	Massachusetts Hazardous Waste Rules – Use and Management of Containers	310 CMR 30.680	Applicable, if hazardous waste is containerized	310 CMR 30.681 through 30.689 prescribe requirements for the use of containers, such as drums, to store hazardous waste. Provides specifications for inter alia labelling and marking, management of containers, inspections, and closure.	Establishes requirements for the management of containers, such as drums, that are used to store hazardous wastes. Alternatives utilizing containers of hazardous waste will comply with this ARAR.	No action, therefore not applicable.	No hazardous waste is expected to be generated by these remedial activities. Any hazardous waste managed in containers will comply with the ARAR through appropriate design and implementation.	
Hazardous Waste - Tanks	Massachusetts Hazardous Waste Rules – Storage and Treatment in Tanks	310 CMR 30.690	Applicable, if hazardous waste is stored and/or transported in tanks	310 CMR 30.691 through 30.699 prescribe requirements for the use of tanks to store and treat hazardous waste. Provides specifications for inter alia design and installation, containment and detection of leaks, general operating requirements, inspections, and closure and post-closure care.	Alternatives utilizing tanks for storage or treatment of hazardous waste will comply with this ARAR.	No action, therefore not applicable.	No hazardous waste is expected to be generated by these remedial activities. Any hazardous waste managed in tanks will comply with the ARAR through appropriate design and implementation.	
Discharges to Surface Waters	Massachusetts Clean Water Act; Surface Water Discharge Permit Regulations	MGL c. 21, §§ 26-53; 314 CMR 3.00	Applicable, if surface water discharge occurs	These regulations require that discharges to waters of the Commonwealth shall not result in exceedances of Massachusetts Surface Water Quality Standards (MSWQS) (314 CMR 4.00).	Any water discharged to surface waters related to excavation and dewatering activities will be treated to meet the substantive discharge standards of the Massachusetts Surface Water Discharge Permit (314 CMR 4.00).	No action, therefore not applicable.	Excavation dewatering, treatment and discharge will likely be required. Any discharge to surface water will be treated to meet these standards.	
Discharges to Surface Water	Massachusetts Clean Water Act; MA Surface Water Quality Standards (MSWQS)	M.G.L. c. 21, §§ 26-53; 314 CMR 4.00	Applicable, if surface water discharge occurs	These standards designate the most sensitive uses for which the various waters of the Commonwealth shall be enhanced, maintained, or protected. Minimum water quality criteria required to sustain the designated uses are established.	Alternatives that incorporate discharges to surface waters will need to have the discharges meet the MSWQS.	No action, therefore not applicable.	Any discharge to surface water from soil excavation/management and excavation dewatering will be treated to meet these standards.	
Hazardous Waste - Facility Discharge Standards	Massachusetts Supplemental Requirements for Hazardous Waste Management Facilities	MGL c. 21, §§ 26-53; 314 CMR 8.00	Applicable, if hazardous waste is generated and surface water discharge occurs	This regulation establishes additional requirements that must be satisfied for a RCRA facility (a wastewater treatment works which manages hazardous waste) that has a wastewater discharge permit.	Alternatives that involve management of hazardous waste prior to discharge to surface waters will meet the substantive standards.	No action, therefore not applicable.	No hazardous waste is expected to be generated by these remedial activities. Any management/treatment of hazardous waste prior to discharge to surface water will comply with the substantive standards.	F21 deals with discharges to surface water but H21 deals with hazarsous soil.

Table 2.1-9
Action-Specific ARARs, Criteria, Advisories, and Guidance; Sediment and Wetland Soil
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement	Wetland Soil and Sediment Alternatives	
						WSS 1 - No Action	WSS 1 - Excavation, Stabilization, and Off-Site Disposal
Solid Waste	Massachusetts Solid Waste Management Regulations	310 CMR 19.000	Applicable, if solid waste is generated	This regulation establishes requirements for the storage, transfer, processing, treatment, disposal, use and reuse of solid waste (including asbestos), including contracting	Any wastes generated by remedial activity that are determined to not be hazardous wastes will be managed in accordance with this regulation .	No action, therefore not applicable.	Any solid waste generated by these remedial alternatives will comply with the ARAR through appropriate design and implementation.
Discharge to Publicly Owned Treatment Works (POTW)	Massachusetts Operation, Maintenance and Pretreatment Standards for Wastewater Treatment Works and Indirect Dischargers	314 CMR 12.00	Applicable, if discharges to a POTW occur	Standards for pretreatment requirements for sources to a POTW.	If remedial actions result in discharges to a POTW, the discharge will be monitored and treated, if necessary, to comply with pretreatment standards.	No action, therefore not applicable.	Any water generated during soil excavation/ management and excavation dewatering will be treated to meet these standards, if the water is to be discharged to the POTW.
Air Emissions	Massachusetts Ambient Air Quality Standards	310 CMR 6.00	Applicable	These regulations establish primary and secondary standards for emissions of sulfur dioxide, particulate matter, carbon monoxide, ozone, nitrogen dioxide, and lead.	Remedial activities would be implemented in accordance with these rules. No air emissions from remedial activities would cause air quality standards to be exceeded.	No action, therefore not applicable.	This alternative will comply with the ARAR by ensuring that dust standards are not exceeded during remedial activities
Air Emissions	Massachusetts Air Pollution Control Regulations	310 CMR 7.00	Applicable	These regulations set emission limits necessary to attain ambient air quality standards including standards for visible emissions (7.06); dust, odor, construction and demolition (7.09); noise (7.10); and asbestos (7.15).	Remedial activities will be implemented in accordance with these rules. No air emissions from remedial activities will cause air quality standards to be exceeded.	No action, therefore not applicable.	This alternative will comply with the ARAR by ensuring that air emissions are not exceeded during remedial activities.

Table 2.1-9
Action-Specific ARARs, Criteria, Advisories, and Guidance; Sediment and Wetland Soil
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement	Wetland Soil and Sediment Alternatives	
						WSS 1 - No Action	WSS 1 - Excavation, Stabilization, and Off-Site Disposal
Sediment/Erosion Control; Stormwater Management	Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas	Prepared for Massachusetts Executive Office of Environmental Affairs (original print March 1997; reprint May 2003)	To Be Considered	Guidance on preventing erosion and sedimentation.	Remedial activities will be managed to control erosion and sedimentation.	No action, therefore not applicable.	This alternative will be designed and managed to control erosion and sedimentation in accordance with this guidance.
Monitoring Wells	Massachusetts Standard References for Monitoring Wells	WSC-310-91	To Be Considered	Guidance on locating, drilling, installing, sampling and decommissioning monitoring wells	Monitoring wells will be installed, maintained and decommissioned based on these guidance standards.	No action, therefore not applicable.	Monitoring wells that are required as part of this alternative would be installed, maintained or decommissioned in accordance with this guidance.
Air Quality	Division of Air Quality Control (DAQC)	DAQC Policy 90-001, re: Noise Regulation,	To Be Considered	Guidance on sound emissions.	The guidance will be used to assess whether any remedial measure exceed Stae noise guidance levels.	No action, therefore not applicable.	This alternative will comply with the ARAR to assess whether any remedial measures exceed State noise guidance levels, and will follow the suggested noise limit to the extent possible in accordance with this guidance. Construction will be scheduled during daylight hours.

Prepared By / Date: JD 03/10/2020
Checked By / Date: JW 03/19/2020

Notes:
ARAR = Applicable or Relevant and Appropriate Requirement
CAA = Clean Air Act
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
CFR = Code of Federal Regulations
CMR = Code of Massachusetts Regulations
IDW = Investigation Derived Waste
MGL = Massachusetts General Law
MSWQC = Massachusetts Surface Water Quality Criteria
NESHAP = National Emission Standards for Hazardous Air Pollutant
NPDES = National Pollution Discharge Elimination System
OSWER = Office of Solid Waste and Emergency Response
POTW = Publicly Owned Treatment Works
ppmw = parts per million by weight
RCRA = Resource Conservation and Recovery Act
USC = United States Code
USEPA = United States Environmental Protection Agency
WWS = Wetland Soil and Sediment

Table 2.1-10
Location-Specific ARARs, Criteria, Advisories, and Guidance; East and South Ditch Surface Water
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement	East Ditch and South Ditch Surface Water Alternatives					
						SW 1 - No Action	SW 2 - Limited Action - SW and GW Monitoring	SW 3 - GW Extraction and Treatment	SW 4 - Targeted GW Extraction and Treatment	SW 5 - Permeable Reactive Barrier (PRB)	SW 6 - Targeted Approach for PRB Installation
Federal Standards											
Floodplains and Wetlands	Floodplain Management and Protection of Wetlands	44 CFR Part 9 (implementing Executive Orders 11988 and 11990)	Applicable	Federal Emergency Management Agency (FEMA) regulations set forth the policy, procedure, and responsibilities to implement and enforce Executive Order 11988 (Floodplain Management) and Executive Order 11990 (Protection of Wetlands). These regulations prohibit activities that adversely affect a federally-regulated wetland unless there is no practicable alternative and the proposed action includes all practicable measures to minimize harm to wetlands that may result from such use. These regulations require the avoidance of impacts associated with the occupancy and modification of federally-designated 100-year and 500-year floodplains and require the avoidance of development within a floodplain wherever there is a practicable alternative. An assessment of impacts to the 500-year floodplain is required for critical actions, which includes siting waste facilities in a floodplain. These regulations require public notice when proposing any action in or affecting floodplains or wetlands.	If there is no practicable alternative method to work in federal jurisdictional wetlands, or 100-year or 500-year floodplains, then all practicable measures will be taken to minimize and mitigate any adverse impacts. Erosion and sedimentation control measures will be adopted during remedial activities to protect these wetlands and floodplains. Standards for excavating and managing contaminated soil, sediment, and groundwater/DAPL, etc. within the 100-year and 500-year floodplains will be attained. After completion of work, there will be no significant net loss of flood storage capacity and no significant net increase in flood stage or velocities. Floodplain habitat will be restored to the extent practicable. Public comment will be solicited as part of the Proposed Plan concerning any proposed alteration to wetlands and floodplains.	No action, therefore not applicable.	Not applicable, wetlands will not be disturbed during monitoring activities.	Some groundwater extraction wells and portions of conveyance piping will need to be installed in floodplain areas. These alternatives will comply with this ARAR through appropriate avoidance, minimization, mitigation and restoration. Federal jurisdictional wetlands altered by construction will be restored in place. All remedial work within any regulated floodplain will result in no significant net loss of flood storage capacity and no significant net increase in flood stage or velocities. Floodplain habitat will be restored, to the extent practicable.		Portions of the PRB will need to be installed in floodplain areas. These alternatives will comply with this ARAR through appropriate avoidance, minimization, mitigation and restoration. Federal jurisdictional wetlands altered by construction will be restored in place. All remedial work within any regulated floodplain will result in no significant net loss of flood storage capacity and no significant net increase in flood stage or velocities. Floodplain habitat will be restored, to the extent practicable.	
Floodplains	RCRA Floodplain Restrictions for Hazardous Waste Facilities	42 USC § 6901 et seq.; 40 CFR § 264.18(b)	Applicable, if hazardous waste is managed within the 100-year floodplain	A hazardous waste treatment, storage, or disposal facility located in a 100-year floodplain must be designed, constructed, operated, and maintained to prevent washout or to result in no adverse effects on human health or the environment if washout were to occur.	Any hazardous waste generated during remedial activities will be managed so that it will not impact floodplain resources.	No action, therefore not applicable.	Not applicable, alternative does not involve hazardous waste treatment, storage, or disposal.	Hazardous waste is not expected to be managed in a 100-year floodplain under these alternatives. . If hazardous wastes are generated during remedial activities they will be managed so that they will not impact floodplain resources.		Hazardous waste is not expected to be managed in a 100-year floodplain under these alternatives. If hazardous wastes are generated during remedial activities they will be managed so that they will not impact floodplain resources.	
Floodplains	RCRA Floodplain Restrictions for Solid Waste Disposal Facilities and Practices	40 CFR § 257.3-1	Applicable, if solid waste is managed within the 100-year floodplain	Solid waste practices must not restrict the flow of a 100-year flood, reduce the temporary water storage capacity of the floodplain, or result in washout of solid waste, so as to pose a hazard to human life, wildlife, or land or water resources.	Any solid waste generated from remedial activities involving excavation activities will be managed so that it will not impact floodplain resources.	No action, therefore not applicable.	Not applicable, alternative will not generate solid waste.	Solid waste is not expected to be managed in a 100-year floodplain under these alternatives. If solid wastes are generated during remedial activities they will be managed so that they will not impact floodplain resources		Solid waste is not expected to be managed in a 100-year floodplain under these alternatives. If solid wastes are generated during remedial activities they will be managed so that they will not impact floodplain resources.	
Wetlands, Aquatic Ecosystem	Clean Water Act (CWA) Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material	33 USC § 1344(b)(1); 40 CFR Parts 230 & 231; and 33 CFR Parts 320-323	Applicable	For discharge of dredged or fill material into water bodies or wetlands, there must be no practicable alternative with less adverse impact on aquatic ecosystem; discharge cannot cause or contribute to violation of state water quality standards or toxic effluent standards or jeopardize threatened or endangered species; discharge cannot significantly degrade waters of U.S.; practicable steps must be taken to minimize and mitigate adverse impacts; and impacts on flood level, flood velocity, and flood storage capacity must be evaluated. Sets standards for restoration and mitigation required as a result of unavoidable impacts to aquatic resources. USEPA must determine which alternative is the "Least Environmentally Damaging Practicable Alternative" (LEDPA) to protect wetland and aquatic resources.	Remedial alternatives will be developed and designed to comply with these regulations. Compensatory wetlands mitigation will need to be performed as necessary to comply with this ARAR. The selected alternative will need to be determined to be the least environmentally damaging practicable alternative that meets the remedial action objectives.	No action, therefore not applicable.	Not applicable, alternative does not involve discharge of any materials.	Under these alternatives, groundwater extraction wells and conveyance piping will impact federal jurisdictional wetlands. The remedial activities will be conducted in accordance with these requirements including, but not limited to, appropriate avoidance, minimization, mitigation and restoration		Under these alternatives, portions of the PRB will impact federal jurisdictional wetlands. The remedial activities will be conducted in accordance with these requirements including, but not limited to, appropriate avoidance, minimization, mitigation and restoration	
Wetlands	U.S. Army Corps of Engineers, New England District Compensatory Mitigation Guidance (09-07-2016)	New England District Compensatory Mitigation Guidance (09-07-2016)	To Be Considered	This Guidance is to be considered when compensatory mitigation to address impacts to federal jurisdiction wetlands is appropriate for a particular remedial activity.	Activities affecting federal jurisdictional wetlands will be conducted in accordance with these guidance standards for mitigation and restoration.	No action, therefore not applicable.	Not applicable, alternative will not cause impacts to wetlands.	Some groundwater extraction wells and portions of conveyance piping will need to be installed in wetland areas. These alternatives will comply with this ARAR through appropriate avoidance, minimization, mitigation and restoration. Federal jurisdictional wetlands altered by construction will be restored in place, to the extent practicable.		Portions of the PRB will need to be installed in wetland areas. This alternative will comply with this ARAR through appropriate avoidance, minimization, mitigation and restoration. Federal jurisdictional wetlands altered by construction will be restored in place, to the extent practicable.	

Table 2.1-10
Location-Specific ARARs, Criteria, Advisories, and Guidance; East and South Ditch Surface Water
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement	East Ditch and South Ditch Surface Water Alternatives					
						SW 1 - No Action	SW 2 - Limited Action - SW and GW Monitoring	SW 3 - GW Extraction and Treatment	SW 4 - Targeted GW Extraction and Treatment	SW 5 - Permeable Reactive Barrier (PRB)	SW 6 - Targeted Approach for PRB Installation
Surface Waters, Wetland/Waterway Habitat for Endangered Species, Migratory Species	Fish and Wildlife Coordination Act	16 USC § 661 et seq. 40 CFR § 6.302(g)	Applicable	Requires that any federal agency proposing to modify a body of water must consult with the U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service, and other related state agencies. That federal agency must consult with the appropriate government entities and also take action to	All appropriate state and federal agencies, such as the USFWS, will be consulted to ensure that losses of or damage to habitat and wildlife will be prevented, mitigated, or compensated to the extent necessary.	No action, therefore not applicable.	Not applicable, alternative will not alter waterways.	Remedial activities will be designed and implemented to prevent and mitigate project related impacts to fish and wildlife. Consultation with appropriate federal agencies will be maintained during planning and implementation of these remedial alternatives that may alter protected resource areas.			
Endangered Species	Endangered Species Act	16 U.S.C. §§ 1531 et seq.; 50 CFR §§ 17.11-17.12; 50 CFR Part 402	Applicable, if endangered species are encountered	This act requires action to avoid jeopardizing the continued existence of listed endangered or threatened species or modification of their habitat.	No known endangered species have been identified in the vicinity of the OCSS. However, protection of endangered species and their habitat will be considered during development and design of remedial alternatives.	No action, therefore not applicable.	No endangered or threatened species have been identified at the Site to date. If endangered or threatened species in the remedial area are identified, remedial activities would avoid actions that adversely affect endangered or threatened species or their habitats.				
Historical/ Archeological Resources	National Historic Preservation Act	54 USC §§ 300101 et seq., 36 CFR Part 800	Applicable, if subject historical resources are present	When a federal agency finds, or is notified, that its activities may have adverse effects on historic properties, such agency is required to consult with federal and state historic preservation officials to resolve the adverse effects, including avoidance, minimization, or mitigation of the adverse effects.	If protected resources are identified in the Site area, measures to avoid, minimize and/or mitigate any adverse effects to protected resources will be implemented in consultation with federal and state historic preservation officials.	No action, therefore not applicable.	If protected resource areas are identified in the remedial area, measures to avoid, minimize and/or mitigate any impacts to protected resource areas will be implemented in consultation with federal and state historic preservation officials.				
Atlantic Flyway	Migratory Bird Treaty Act	16 USC § 703 et seq.	Applicable, if subject protected species are present	Protects migratory birds, their nests and eggs. A depredation permit issued by the U.S. Fish and Wildlife Service (USFWS) is required to take, possess, or transport migratory birds or disturb their nests, eggs, or young.	Remedial activities will be evaluated to protect migratory birds, their nests and eggs. If migratory bird protected areas are identified in the site area, measures to avoid, minimize and/or mitigate any impacts to protected resource areas will be implemented in consultation with appropriate USFWS officials.	No action, therefore not applicable.	If migratory bird protected areas are identified within the remedial area, measures to avoid, minimize and/or mitigate any impacts to protected resource areas will be implemented in consultation with appropriate USFWS officials.				
State Standards											
Floodplains, Wetlands, Surface Waters	Massachusetts Wetland Protection Act and Regulations	MGL c. 131, § 40; 310 CMR 10.00	Applicable if alternative alters wetlands or floodplains	These regulations restrict dredging, filling, altering, or polluting inland wetland resource areas (defined as areas within the 100-year floodplain) and buffer zones (100 feet of a vegetated wetland or 200 feet from a perennial stream), and impose performance standards for work in such areas. Protected resource areas include: 10.54 (Bank); 10.55 (Bordering Vegetated Wetlands); 10.56 (Land under Water Bodies and Waterways); 10.57 (Land Subject to Flooding); and 10.58 (Riverfront Area).	Any remedial activity conducted within 100 feet of a state regulated wetland resource area or 200 feet from a perennial stream will comply with the substantive requirements of these regulations. Mitigation of impacts on state wetland resource areas will be addressed.	No action, therefore not applicable.	NNot applicable, this alternative does not involve earthwork or other alterations to the wetland or floodplain areas.	Some groundwater extraction wells and portions of conveyance piping will need to be installed in wetland and/or floodplain areas. These alternatives will comply with this ARAR through appropriate avoidance, minimization, mitigation and restoration. No net loss of flood storage capacity and no net increase in flood stage or velocities will result. Floodplain habitat will be restored, to the extent practicable. Any remedial activity to be performed within wetlands and the 100 foot buffer zone or 200 feet from a perennial stream will be in accordance with the substantive requirements of these regulations.		Portions of the PRB will need to be installed in wetland and/or floodplain areas. These alternatives will comply with this ARAR through appropriate avoidance, minimization, mitigation and restoration. No net loss of flood storage capacity and no net increase in flood stage or velocities will result. Floodplain habitat will be restored, to the extent practicable. Any remedial activity to be performed within wetlands and the 100 foot buffer zone or 200 feet from a perennial stream will be in accordance with the substantive requirements of these regulations.	
Floodplains	Massachusetts Hazardous Waste Regulations, Location Standards for Land Subject to Flooding	310 CMR 30.701	Applicable, if hazardous waste is managed within a floodplain	This regulation sets forth criteria for siting hazardous waste facilities within land subject to flooding (as defined under the Massachusetts Wetland Protection Act standards). Any new or expanded hazardous waste storage or treatment facility (which only receives hazardous waste from on-site sources), the active portion of which is located within the boundary of land subject to flooding from the statistical 100-year frequency storm, shall be flood-proofed.	To the extent any hazardous waste is generated during the remedial activities, the wastes will be managed so that it will not impact floodplain resources.	No action, therefore not applicable.	Not applicable, alternative does not involve hazardous waste treatment, storage, or disposal.	Hazardous waste is not expected to be managed in a 100-year floodplain under these alternatives. If hazardous wastes are generated during remedial activities, they will be managed so that they will not impact floodplain resources.		Hazardous waste is not expected to be managed in a 100-year floodplain under these alternatives.. If hazardous wastes are generated during remedial activities, they will be managed so that they will not impact floodplain resources.	
Wetlands, Aquatic Ecosystem	Massachusetts Clean Water Act; Massachusetts Water Quality Certification for Discharge of Dredged or Fill Material	MGL c. 21, §§ 26-53; 314 CMR 9.00	Applicable, if alternative involves filling of wetlands	For discharges of dredged or fill material, there must be no practicable alternative with less adverse impact on the aquatic ecosystem; appropriate and practicable steps must be taken to avoid and minimize potential adverse impacts to wetlands and land under water; stormwater discharges must be controlled with BMPs; and there must not be substantial adverse impacts to the physical, chemical, or biological integrity of surface waters. For dredging and dredged material management, there must be no practicable alternative with less adverse impact on the aquatic ecosystem; and if avoidance is not possible, then minimize, or if neither avoidance or minimization are possible, then mitigate potential adverse impacts	The remedial alternatives' effects on the aquatic ecosystem will be evaluated and avoided, and/or minimized. Compensatory mitigation will need to be performed as necessary to comply with this ARAR. The selected alternative will need to be determined to be the least environmentally damaging practicable alternative that meets the remedial action objectives. Any required removal of soil/sediment from wetland or surface water areas will be designated for eventual restoration. Excavation and filling activities to be performed impacting the aquatic ecosystem will be in accordance with the substantive requirements of these regulations	No action, therefore not applicable.	Not applicable, alternative does not involve discharge of any materials.	Under these alternatives dredging/filling of wetlands during installation of groundwater wells and associated conveyance piping will be conducted so as to not impair surface water quality.		Under these alternatives dredging/filling of wetlands during PRB installation will be conducted so as to not impair surface water quality.	

Table 2.1-10
Location-Specific ARARs, Criteria, Advisories, and Guidance; East and South Ditch Surface Water
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Location Characteristic	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement	East Ditch and South Ditch Surface Water Alternatives					
						SW 1 - No Action	SW 2 - Limited Action - SW and GW Monitoring	SW 3 - GW Extraction and Treatment	SW 4 - Targeted GW Extraction and Treatment	SW 5 - Permeable Reactive Barrier (PRB)	SW 6 - Targeted Approach for PRB Installation
Endangered Species	Massachusetts Endangered Species Regulations	321 CMR 10.00	Applicable, if endangered species are encountered	Requires action to regulate the impact to state listed endangered or threatened species or their habitats. Actions must be conducted in a manner that minimizes the impact to Massachusetts-listed rare, threatened, or endangered species, and species listed by the Massachusetts Natural	No known endangered species have been identified in the vicinity of the Site. However, if identified, protection of state listed endangered species and their habitat will be considered during design and implementation of remedial alternatives.	No action, therefore not applicable.	No endangered or threatened species have been identified at the Site to date. If endangered or threatened species in the remedial area are identified, remedial activities would avoid actions that adversely affect endangered or threatened species or their habitats.				
Historical/ Archeological Resources	Massachusetts Antiquities Act; Massachusetts Historical Commission Regulations; Protection of Properties Included in the State Register of Historic Places	MGL c. 9, §§ 26-27C; 950 CMR 70.00 and 71.00	Applicable, if subject historical resources are present.	Projects must eliminate, limit, or mitigate adverse effects to properties listed in the State Register of Historic Places (historic and archaeological properties). Establishes coordination with the National Historic Preservation Act.	If protected resources are identified in the Site area, measures to avoid, minimize and/or mitigate any impacts to protected resources will be implemented in consultation with federal and state historic preservation officials.	No action, therefore not applicable.	If protected resource areas are identified in the remedial area, measures to avoid, minimize and/or mitigate any impacts to protected resource areas will be implemented in consultation with federal and state historic preservation officials.				
Area of Critical Environmental Concern	Massachusetts Areas of Critical Environmental Concern (ACECs) Regulations	310 CMR 12.00	Applicable, if ACEC is identified	An ACEC is of regional, state, or national importance or contains significant ecological systems with critical interrelationships among a number of components. An eligible area must contain features from four or more of the following groups: (1) fisheries, (2) coastal features, (3) estuarine wetlands, (4) inland wetlands, (5) inland surface waters, (6) water supply areas (e.g., aquifer recharge area); (7) natural hazard areas (e.g., floodplain); (8) agricultural areas; (9) historical/archeological resources; (10) habitat resources (e.g., for endangered wildlife); or (11) special use areas. After an area is designated as an ACEC, the aim is to preserve and restore these areas.	No known ACECs have been identified at the Site. If an ACEC is identified in the Site area, activities will be controlled to minimize impacts to affected species or resources if identified.	No action, therefore not applicable.	No known ACECs have been identified at the site. If an ACEC is identified in the remediation area, remedial activities will be controlled to minimize impacts to affected species or resources.				

Prepared By / Date: KW 03/16/2020
Checked By / Date: JW 3/20/2020

Notes:
ACEC = Areas of Critical Environmental Concern
ARAR = Applicable or Relevant and Appropriate Requirement
BMP = Best Management Practice
CFR = Code of Federal Regulations
CMR = Code of Massachusetts Regulations
CWA = Clean Water Act
DAPL = Dense Aqueous Phase Liquid
EDSD = East Ditch and South Ditch
FEMA = Federal Emergency Management Agency
GW = Groundwater
LEDPA = Least Environmentally Damaging Practicable Alternative
MGL = Massachusetts General Law
PRB = Permeable Reactive Barrier
RCRA = Resource Conservation and Recovery Act
SW = Surface Water
USEPA = United States Environmental Protection Agency
USFWS = United States Fish and Wildlife Service
USC = United States Code

Table 2.1-11
Action-Specific ARARs, Criteria, Advisories, and Guidance; East and South Ditch Surface Water
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement	East Ditch and South Ditch Surface Water Alternatives					
						SW 1 - No Action	SW 2 - Limited Action - SW and GW Monitoring	SW 3 - GW Extraction and Treatment	SW 4 - Targeted GW Extraction and Treatment	SW 5 - Permeable Reactive Barrier (PRB)	SW 6 - Targeted Approach for PRB Installation
Federal Standards											
Discharges to Surface Water; Storm Water Controls	Clean Water Act; National Pollutant Discharge Elimination System (NPDES)	40 CFR Parts 122 and 125	Applicable (and if surface water discharge occurs, discharge standards are also applicable)	These requirements include storm water standards for construction activities disturbing more than one acre and requirements for stormwater discharges from hazardous waste treatment, storage, and disposal facilities. These requirements also specify the permissible concentration or level of contaminants in the discharge from any point source to waters of the United States.	Best management practices will be used to control and manage stormwater runoff during construction and operation. Alternatives that incorporate discharges to surface waters will need to have the discharges meet the substantive discharge standards (the Massachusetts Surface Water Discharge Permit Program [314 CMR 3.00] has similar requirements).	No action, therefore not applicable.	Not applicable, this alternative does not include discharge to surface waters.	Extracted groundwater discharged to surface water will be treated to meet these standards. Best management practices will be used to control and manage stormwater runoff during construction for remedial activities.		Not applicable, these alternatives do not include discharge to surface water.	
Monitoring Surface Water	Clean Water Act (CWA) National Recommended Water Quality Criteria (NRWQC); Aquatic Life Criteria	Established in accordance with 33 USC § 1314(a)	To Be Considered (TBC)	NRWQC are health-based criteria developed for chemical constituents in surface water. They have been developed to protect aquatic life and human health from harmful effects due to exposure to chemically impacted surface water. Performance standards to be used for monitoring surface water during remedial activities.	NRWQC were used to derive ecological surface water PRGs that would be protective of ecological receptors in surface water, which will be used to monitor surface water during remedial action to ensure that the alternatives are successful in reducing contaminant levels in surface water to be protective of ecological receptors.	No action, therefore not applicable.	Site-specific ecological surface water performance standards derived from NRWQC will be used to ensure that the remedial alternative is successful in reducing contaminant levels in surface water to be protective of ecological receptors.				
Discharge to a Publicly Owned Treatment Works (POTW)	General Pretreatment Regulations for Existing and New Sources of Pollution	40 CFR Part 403	Applicable, if discharge to a POTW occurs.	Standards for discharge into a Publicly Owned Treatment Works (POTW).	If remedial actions result in discharges to a POTW, the discharge will be monitored and treated, if necessary, to comply with pretreatment standards.	No action, therefore not applicable.	Not applicable, this alternative does not include discharge to a POTW.	Extracted groundwater discharged to a POTW will be treated to meet the pretreatment standards.		Not applicable, these alternatives do not include discharge to a POTW.	
Investigation-Derived Waste (IDW)	Guide to Management of Investigation-Derived Wastes	USEPA OSWER Publication 9345.3-03FS, January 1992	To Be Considered	Guidance on management of IDW in a manner that ensures protection of human health and the environment.	IDW generated as part of this remedial alternative will be managed based on guidance standards.	No action, therefore not applicable.	IDW generated as part of pre-design investigations for the remedy will by managed in compliance with this guidance.				
Hazardous Waste Treatment, Storage, Disposal	Resource Conservation and Recovery Act (RCRA) Subtitle C; Hazardous Waste Identification; Generator and Handler Requirements; Tracking Requirements; Storage, Treatment and Disposal Requirements; Groundwater Monitoring Requirements; Closure and Post Closure Requirements	42 USC § 6901 et seq.; 40 CFR Parts 260-262, Part 264	Applicable, if hazardous waste is generated.	Federal standards used to identify, manage, and dispose of hazardous waste. Massachusetts has been delegated the authority to administer these RCRA standards through its state hazardous waste management regulations.	Any wastes generated during remedial activities will be analyzed under these standards to determine whether they are listed or characteristic hazardous waste. Non-hazardous wastes will be disposed of appropriately. Any waste generated during remedial activities that is determined to be hazardous waste will be managed in accordance with these regulations. Alternatives generating hazardous waste or using treatment, storage or disposal facilities for hazardous waste will be implemented to comply with this ARAR.	No action, therefore not applicable.	No hazardous waste is expected to be generated by these remedial activities. Any management of hazardous waste would be in accordance with these regulations.			Soil excavated for PRB construction and spent PRB media will be analyzed under these standards to determine whether it is hazardous waste. Any hazardous waste would be managed in accordance with these regulations.	

Table 2.1-11
Action-Specific ARARs, Criteria, Advisories, and Guidance; East and South Ditch Surface Water
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement	East Ditch and South Ditch Surface Water Alternatives					
						SW 1 - No Action	SW 2 - Limited Action - SW and GW Monitoring	SW 3 - GW Extraction and Treatment	SW 4 - Targeted GW Extraction and Treatment	SW 5 - Permeable Reactive Barrier (PRB)	SW 6 - Targeted Approach for PRB Installation
Hazardous Waste - Air Emissions	RCRA, Air Emission Standards for Process Vents; Equipment Leaks; Tanks, Surface Impoundments, and Containers	40 CFR Part 264, Subparts AA, BB, and CC	Applicable, if hazardous wastes: will be managed by process vents with volatile organic concentrations of at least 10 parts per million by weight (ppmw) (Subpart AA); will be managed by equipment with organic concentrations of at least 10% by weight (Subpart BB); or will be managed in tanks, surface impoundments, or containers, and thresholds are met (Subpart CC). Relevant and Appropriate, if organics less than thresholds or for non-hazardous waste. Relevant and Appropriate, if less than thresholds.	RCRA emissions standards not delegated to the State. Standards for process vents for systems that manage hazardous wastes that have organic concentrations of at least 10 ppmw. Standards for air equipment leaks for systems that manage hazardous wastes with organic concentrations of at least 10% by weight. Standards for tanks, surface impoundments, and containers that manage hazardous wastes with average VOC concentrations of 500 ppm by weight or greater.	Process vents, air equipment, tanks, surface impoundments or containers will be managed in accordance with these air emission regulations.	No action, therefore not applicable.	No waste generated in this remedial alternative is expected to have concentrations over these thresholds. Management of VOCs in excavated soil and sediment would be in accordance with these air emission regulations.			No waste generated in this remedial alternative is expected to have concentrations over these thresholds. Management of VOCs in excavated soil and sediment would be in accordance with these air emission regulations.	
State Standards											
Discharges to Surface Waters	Massachusetts Clean Water Act; Surface Water Discharge Permit Regulations	MGL c. 21, §§ 26-53; 314 CMR 3.00	Applicable, if surface water discharge occurs	These regulations require that discharges to waters of the Commonwealth shall not result in exceedances of Massachusetts Surface Water Quality Standards (MSWQS) (314 CMR 4.00).	Any water discharged to surface waters related to excavation and dewatering activities will be treated to meet the substantive discharge standards of the Massachusetts Surface Water Discharge Permit (314 CMR 4.00).	No action, therefore Not applicable.	Not applicable, this alternative does not include surface water discharge.	Extracted groundwater discharged to surface water will be treated to meet these standards.		Not applicable, these alternatives do not include discharge to surface water	
Discharges to Surface Water	Massachusetts Clean Water Act; MA Surface Water Quality Standards (MSWQS)	M.G.L. c. 21, §§ 26-53; 314 CMR 4.00	Applicable, if surface water discharge occurs	These standards designate the most sensitive uses for which the various waters of the Commonwealth shall be enhanced, maintained, or protected. Minimum water quality criteria required to sustain the designated uses are established.	Alternatives that incorporate discharges to surface waters will need to have the discharges meet the MSWQS.	No action, therefore Not applicable.	Not applicable, this alternative does not include surface water discharge.				
Hazardous Waste - Facility Discharge Standards	Massachusetts Supplemental Requirements for Hazardous Waste Management Facilities	MGL c. 21, §§ 26-53; 314 CMR 8.00	Applicable, if hazardous waste is generated and surface water discharge occurs	This regulation establishes additional requirements that must be satisfied for a RCRA facility (a wastewater treatment works which manages hazardous waste) that has a wastewater discharge permit.	Alternatives that involve management of hazardous waste prior to discharge to surface waters will meet the substantive standards.	No action, therefore not applicable.	Not applicable, this alternative does not include management of hazardous waste	Any management/treatment of groundwater that is a hazardous waste prior to discharge to surface water will comply with the substantive standards		Not applicable, these alternatives do not include management of hazardous waste prior to surface water discharge	

Table 2.1-11
Action-Specific ARARs, Criteria, Advisories, and Guidance; East and South Ditch Surface Water
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement	East Ditch and South Ditch Surface Water Alternatives					
						SW 1 - No Action	SW 2 - Limited Action - SW and GW Monitoring	SW 3 - GW Extraction and Treatment	SW 4 - Targeted GW Extraction and Treatment	SW 5 - Permeable Reactive Barrier (PRB)	SW 6 - Targeted Approach for PRB Installation
Hazardous Waste Identification	Massachusetts Hazardous Waste Management Rules for Identification and Listing of Hazardous Wastes	310 CMR 30.100	Applicable, if hazardous waste is generated	Massachusetts is delegated to administer RCRA through its state regulations. These regulations establish requirements for determining whether wastes are either listed or characteristic hazardous waste.	These Massachusetts regulations supplement federal RCRA requirements. Any wastes generated during remedial activities will be analyzed under these standards to determine whether they are listed or characteristic hazardous wastes. Hazardous and nonhazardous wastes will be managed and disposed of appropriately.	No action, therefore not applicable.	Not applicable, this alternative does not include management of hazardous waste.	No hazardous waste is expected to be generated by these remedial activities. Any management of hazardous waste would be in accordance with these regulations.		Soil excavated for PRB construction and spent PRB media will be analyzed under these standards to determine whether it is hazardous waste. Any hazardous would be managed in accordance with these regulations.	
Hazardous Waste - Generator Standards	Massachusetts Hazardous Waste Rules – Requirements for Generators	310 CMR 30.300	Applicable, if hazardous waste is generated	These regulations contain requirements for hazardous waste generators. The regulations apply to generators of sampling waste and also apply to the accumulation of waste prior to off-site disposal.	If any remedial activity generates hazardous wastes, the wastes will be managed in accordance with the substantive requirements of these regulations.	No action, therefore not applicable.	Not applicable, this alternative does not include management of hazardous waste.	No hazardous waste is expected to be generated by these remedial activities. Any hazardous waste generated will comply with the ARAR through appropriate design, implementation and operation.		Any excavated soil or spent PRB media that is hazardous waste will comply with the ARAR through appropriate design, implementation and operation.	
Hazardous Waste - Management Facility Standards	Massachusetts Hazardous Waste Rules – Management Standards for All Hazardous Waste Facilities	310 CMR 30.500	Applicable, if hazardous waste is generated	General facility requirements for waste analysis, security measures, inspections, and training requirements. Section 30.580 addresses closure. Section 30.590 addresses post-closure of hazardous waste facilities. Section 30.513 requires a general waste analysis of any hazardous waste.	Any waste generated during remedial activities that is determined to be hazardous waste will be managed in accordance with these regulations. Alternatives generating hazardous waste or using treatment, storage or disposal facilities for hazardous waste will be implemented to comply with this ARAR.	No action, therefore not applicable.	Not applicable, this alternative does not include management of hazardous waste.	No hazardous waste is expected to be generated by these remedial activities. Any management of hazardous waste will comply with the ARAR through appropriate design, implementation and operation.		Any excavated soil or spent PRB media that is hazardous waste will comply with the ARAR through appropriate design, implementation and operation.	
Hazardous Waste - Containers	Massachusetts Hazardous Waste Rules – Use and Management of Containers	310 CMR 30.680	Applicable, if hazardous waste is containerized	310 CMR 30.681 through 30.689 prescribe requirements for the use of containers, such as drums, to store hazardous waste. Provides specifications for inter alia labelling and marking, management of containers, inspections, and closure.	Establishes requirements for the management of containers, such as drums, that are used to store hazardous wastes. Alternatives utilizing containers of hazardous waste will comply with this ARAR.	No action, therefore not applicable.	Not applicable, this alternative does not include management of hazardous waste.	No hazardous waste is expected to be generated by these remedial activities. Any hazardous waste managed in containers will comply with the ARAR through appropriate design and implementation.		Any excavated soil or spent PRB media that is hazardous waste and managed in containers will comply with the ARAR through appropriate design, implementation and operation.	
Hazardous Waste - Tanks	Massachusetts Hazardous Waste Rules – Storage and Treatment in Tanks	310 CMR 30.690	Applicable, if hazardous waste is stored and/or transported in tanks	310 CMR 30.691 through 30.699 prescribe requirements for the use of tanks to store and treat hazardous waste. Provides specifications for inter alia design and installation, containment and detection of leaks, general operating requirements.	Alternatives utilizing tanks for storage or treatment of hazardous waste will comply with this ARAR.	No action, therefore not applicable.	Not applicable, this alternative does not include management of hazardous waste.	No hazardous waste is expected to be generated by these remedial activities. Any hazardous waste managed in tanks will comply with the ARAR through appropriate design and implementation.		Any excavated soil or spent PRB media that is hazardous waste and managed in tanks will comply with the ARAR through appropriate design, implementation and operation.	
Air Emissions	Massachusetts Air Pollution Control Regulations	310 CMR 7.00	Applicable	These regulations set emission limits necessary to attain ambient air quality standards including standards for visible emissions (7.06); dust, odor, construction and demolition (7.09); noise (7.10); and asbestos (7.15).	Remedial activities will be implemented in accordance with these rules. No air emissions from remedial activities will cause air quality standards to be exceeded.	No action, therefore not applicable.	Not applicable, this alternative does not include activities that might affect air emissions.	These remedial alternatives will comply with the ARAR by ensuring that air emissions are not exceeded during remedial activities.			
Solid Waste	Massachusetts Solid Waste Management Regulations	310 CMR 19.000	Applicable, if solid waste is generated	This regulation establishes requirements for the storage, transfer, processing, treatment, disposal, use and reuse of solid waste (including asbestos), including contracting for disposal or transport of solid waste.	Any wastes generated by remedial activity that are determined to not be hazardous wastes will be managed in accordance with this regulation .	No action, therefore not applicable.	Not applicable, this alternative does not include management of solid waste.	No solid waste is expected to be generated by these remedial activities. Any solid waste managed in tanks will comply with the ARAR through appropriate design and implementation.		No solid waste is expected to be generated by these remedial activities. Any management/treatment of solid waste will comply with the substantive standards.	
Discharge to Publicly Owned Treatment Works (POTW)	Massachusetts Operation, Maintenance and Pretreatment Standards for Wastewater Treatment Works and Indirect Dischargers	314 CMR 12.00	Applicable, if discharges to a POTW occur	Standards for pretreatment requirements for sources to a POTW.	If remedial actions result in discharges to a POTW, the discharge will be monitored and treated, if necessary, to comply with pretreatment standards.	No action, therefore not applicable.	Not applicable, this alternative does not include discharge to a POTW.	Any water generated during soil excavation and excavation dewatering will be treated to meet these standard, if the water is to be discharged to the POTW.			
Air Quality	Division of Air Quality Control (DAQC)	DAQC Policy 90-001, re: Noise Regulation,	To Be Considered	Guidance on sound emissions.	The guidance will be used to assess whether any remedial measure exceed Stae noise guidance levels.	No action, therefore not applicable.	These remedial alternatives will comply with the ARAR to assess whether any remedial measures exceed State noise guidance levels, and will follow the suggested noise limit to the extent possible in accordance with this guidance. Construction will be scheduled during daylight hours.				

Table 2.1-11
Action-Specific ARARs, Criteria, Advisories, and Guidance; East and South Ditch Surface Water
Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Action/Trigger	Requirement	Citation	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement	East Ditch and South Ditch Surface Water Alternatives					
						SW 1 - No Action	SW 2 - Limited Action - SW and GW Monitoring	SW 3 - GW Extraction and Treatment	SW 4 - Targeted GW Extraction and Treatment	SW 5 - Permeable Reactive Barrier (PRB)	SW 6 - Targeted Approach for PRB Installation
Monitoring Wells	Massachusetts Standard References for Monitoring Wells	WSC-310-91	To Be Considered	Guidance on locating, drilling, installing, sampling and decommissioning monitoring wells	Monitoring wells will be installed, maintained and decommissioned based on these guidance standards.	No action, therefore not applicable.	Monitoring wells that are required as part of the alternative would be installed, maintained, and decommissioned in accordance with this guidance.				
Sediment/Erosion Control; Stormwater Management	Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas	Prepared for Massachusetts Executive Office of Environmental Affairs (original print March 1997; reprint May 2003)	To Be Considered	Guidance on preventing erosion and sedimentation.	Remedial activities will be managed to control erosion and sedimentation.	No action, therefore not applicable.	Not applicable, this remedial alternative does not include activities that might affect or cause erosion and sedimentation.	Remedial alternatives will be designed to meet the substantive requirements of this guidance to control erosion and sedimentation.			

Prepared By / Date: KW 03/16/2020
Checked By / Date: JW 3/20/2020

Notes:
ARAR = Applicable or Relevant and Appropriate Requirement
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
CFR = Code of Federal Regulations
CMR = Code of Massachusetts Regulations
IDW = Investigation Derived Waste
MGL = Massachusetts General Law
MSWQC = Massachusetts Surface Water Quality Criteria
NPDES = National Pollution Discharge Elimination System
OSWER = Office of Solid Waste and Emergency Response
RCRA = Resource Conservation and Recovery Act
USEPA = United States Environmental Protection Agency

Table 2.1-12
Ecological and Human Health PRGs for Soil, Sediment, and Surface Water

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

		Chromium		BEHP		Ammonia		B(a)P	
Medium	**Units**	**PRG**	**Basis**	**PRG**	**Basis**	**PRG**	**Basis**	**PRG**	**Basis**
Upland Soil	mg/kg	1,000	A	3	E	NA	I	NA	M
Wetland Soil	mg/kg	600	B	20	F	NA	J	NA	N
Streambank Soil & Aquatic Sediment	mg/kg	100	C	100	G	NA	K	NA	O
Surface Water	mg/L	0.11	D	NA	H	15	L	0.0009	P

Prepared by: APP 12/16/2019
Checked by: ETB 07/29/2020

Notes:

A = Geometric mean of NOAEL-PRG & LOAEL-PRG for robin at EA-5 (1,004 mg/kg rounded to 1000 mg/kg)
B = Geometric mean of NOAEL-PRG & LOAEL-PRG for marsh wren at Off-PWD (641 mg/kg rounded to 600 mg/kg)
C = Probable Effect Concentration (110 mg/kg) and conclusion from REACH dossier (100 mg/kg) rounded to 100 mg/kg)
D = Arithmetic mean of hardness-adjusted CCC at seven water bodies at Site (Table 3.12-3 of BERA)
E = Geometric mean of NOAEL-PRG & LOAEL-PRG for robin at EA-5
F = Geometric mean of NOAEL-PRG & LOAEL-PRG for marsh wren at Lower South Ditch (21 mg/kg rounded to 20 mg/kg)
G = Conclusion from REACH dossier (https://echa.europa.eu/registration-dossier/-/registered dossier/15358/6/1)
H = Conclusion from REACH dossier that there is no aquatic toxicity at the solubility limit of BEHP
I = No data available
J = No data available
K = No data available
L = CCC for Site-specific pH and temperature during Spring months at East Ditch, applied to all surface water at Site
M= Baseline human health and ecological risk assessments concluded PRGs are not necessary
N= Baseline human health and ecological risk assessments concluded PRGs are not necessary
O= Baseline human health and ecological risk assessments concluded PRGs are not necessary
P= PRG at 10^{-4} cancer risk for Trespasser Off-Property West Ditch

Table 2.1-12
Ecological and Human Health PRGs for Soil, Sediment, and Surface Water

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

Notes (continued):

Streambank soil is defined as soil between top of bank on each side of waterbody.
Aquatic sediment is defined as sediment that is usually covered with surface water.
Soil/sediment PRG compliance = geometric or arithmetic mean ≤ PRG based on data distribution (lognormal or normal, respectively)-for soil, compliance with "accessible" soil.
Surface Water PRG compliance = geometric or arithmetic mean ≤ PRG based on data distribution (lognormal or normal, respectively).

B(a)P = Benzo(a)pyrene
BEHP = bis-2-ethylhexyl phthalate
CCC = Criterion Continuous Concentration from EPA National Recommended Water Quality Criteria (NRWQC)
EA = Exposure Area
LOAEL = Lowest Observed Adverse Effect Level
NA = Not Available
NOAEL = No Observed Adverse Effect Level
off-PWD = Off Property West Ditch
PRG = Preliminary Remedial Goal
REACH = European Regulation on Registration, Evaluation, Authorization, and Restriction of Chemicals

Table 2.3-1
Screening of Remedial Technologies – Upland Soils (Including TMPs)

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

General Response Action	Remediation Technology and Process Option	Description of Process Option	Effectiveness	Implementability	Cost	Retained	Screening Comments
No Action	None	No action taken	Not effective	Implementable	No Cost	Yes	Required for baseline comparison
Institutional Controls	<u>Access and Use Restrictions</u>						
	Notice of Activity and Use Limitations (NAULs)	Intended to prevent unacceptable exposures to contamination by identifying activities and uses that are consistent with maintaining a condition of No Significant Risk.	Effective	Implementable	Low	Yes	NAULs would include language to address potential vapor intrusion concerns associated with future buildings that may be constructed on the Property. Would also include requirements for health & safety plans to mitigate potential inhalation exposures for construction workers during excavation activities.
	<u>Environmental Monitoring</u>						
	Soil and sediment sampling	Collection and analysis of soil samples, and potentially soil gas samples.	Effective	Implementable	Low	Yes	May be used in conjunction with other technologies and to assess remedy effectiveness.
Containment							
	<u>Capping</u>	Install a cover over contaminated soil to reduce weathering and erosion and render the contaminated soil inaccessible to receptors.	Effective.	Implementable.	Medium	Yes	Retained for chromium- and BEHP-impacted soil; Would reduce weathering and erosion and render the contaminated soil inaccessible to receptors.
Treatment	<u>In-situ Chemical Oxidation Injections</u>	Chemical oxidant is injected into the subsurface using direct push drilling techniques to enhance reduction/degradation of contaminants.	Chemical oxidation effective for VOCs such as TMPs, and somewhat effective for SVOCs, such as BEHP.	Implementable; however, difficult to effectively deliver the reagents thoroughly throughout the subsurface treatment zone. May require multiple injection events to reach cleanup levels and for oxidation of daughter products.	Medium	No	Eliminated due to implementability concerns. Additionally, oxidation would convert trivalent chromium to hexavalent chromium, which is currently not a COC.

Table 2.3-1
Screening of Remedial Technologies – Upland Soils (Including TMPs)

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

General Response Action	Remediation Technology and Process Option	Description of Process Option	Effectiveness	Implementability	Cost	Retained	Screening Comments
Treatment (Continued)	Air Sparging/Soil Vapor Extraction	Relies on the mass transfer stripping of VOCs in soils using a suitable vacuum source.	Effective for removal of VOCs such as TMPs. Not effective for chromium and BEHP.	Implementable	Medium-High	Yes	Effective and implementable. Because there are currently no occupied buildings in the HHRA EA7 area, the vapor migration pathway is incomplete and treatment of TMPs is not necessary under current site conditions for direct contact or vapor intrusion. However, the technology has been retained because it would be effective and implementable to address TMPs concerns related to potential future buildings and construction worker TMP inhalation during excavation.
	Ex-situ Low Temperature Thermal Desorption	The process removes and destroys organic compounds.	Effective for treatment of excavated soil contaminated with VOCs such as TMPs. Not effective for chromium or BEHP.	Implementable. High energy costs associated with technology. Unacceptable short-term exposure risks related to excavation of TMP-impacted soil and releasing VOCs.	Medium-High	No	Eliminated due to short-term exposure risks to workers and nearby receptors.
	In-situ Thermal Desorption	The process removes, oxidizes, or destroys organic compounds, but may not effectively treat inorganic constituents.	Effective for removal of VOCs such as TMPs. Not effective for chromium or BEHP.	Implementable; but high energy costs. Air monitoring program needed.	High	Yes	Thermal desorption is effective and implementable for TMPs in soil. Smaller treatment area needed than for ex-situ thermal desorption. Therefore, in-situ treatment was retained for further consideration.
	Barriers/Ventilation/Depressurization	Sub-slab gas-impermeable barriers and sub-slab ventilation or depressurization are methods to mitigate subsurface vapors from entering a building through the building's basement or floor slab. Vapors removed from beneath the building are then discharged to the atmosphere.	Effective for removal of VOCs if future buildings are constructed in the vicinity of HHRA EA7, EA3, and Lake Poly.	Implementable in the future to address VOCs (e.g., TMPs) if future buildings are constructed in the vicinity of HHRA EA7.	Medium-High	Yes	Effective, and implementable in the future if future buildings are constructed in the vicinity of Plant B and EA7, EA3, and Lake Poly (EA1).

Table 2.3-1
Screening of Remedial Technologies – Upland Soils (Including TMPs)

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

General Response Action	Remediation Technology and Process Option	Description of Process Option	Effectiveness	Implementability	Cost	Retained	Screening Comments
Removal							
	<u>Mechanical excavation</u>	Excavation using conventional earthmoving equipment.	Effective. Interrupts direct exposure pathway and reduces erosion and leaching if combined with protective disposal option.	Implementable. High volatility of TMPs may require work be conducted in Level C and a perimeter air monitoring program would be required.	Medium	Yes	Retained; May be used in conjunction with other technologies.
Disposal							
	<u>Off-Site Disposal</u>	Permitted landfill	Effective	Implementable	Medium	Yes	Retained; May be used in conjunction with other technologies.

Prepared by: APP 12/13/2019
Checked by: JDW 04/02/2020

Notes:
COC = Chemical of Concern
EA = Exposure Area
VOC = Volatile Organic Compound
HHRA = Human Health Risk Assessment
TMPs = Trimethylpentenes

Table 2.3-2
Screening of Remedial Technologies – Sediment and Wetland Soil

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

General Response Action	Remediation Technology and Process Option	Description of Process Option	Effectiveness	Implementability	Cost	Retained	Screening Comments
No Action	None	No action taken	Not effective	Implementable	No Cost	Yes	Required for baseline comparison
Institutional Controls	Access and Use Restrictions						
	Notice of Activity and Use Limitations (NAULs)	Intended to prevent unacceptable exposures to contamination by identifying activities and uses that are consistent with maintaining a condition of No Significant Risk.	Effective	Implementable	Low	No	Remediation of wetland soil and sediment is to address risk to ecological receptors; therefore, NAULs are not necessary.
	Environmental Monitoring						
	Soil and sediment sampling	Collection and analysis of soil and sediment samples.	Effective	Implementable	Low	Yes	May be used in conjunction with other technologies and to assess remedy effectiveness.
Containment	Capping						
	Subaqueous Cap	Install geosynthetic barrier over contaminated sediment in South Ditch.	Not effective	Not implementable due to very minimal water depth in South Ditch.	Medium-High	No	Would degrade ecological habitat of South Ditch or wetland areas. Would not prevent groundwater discharge. Water depth too shallow to implement.
	Terrestrial Cap	Install a soil barrier over contaminated sediment in South Ditch.	Not effective	Not implementable due to very minimal water depth in South Ditch.	Medium-High	No	Would degrade ecological habitat of South Ditch. Would not prevent groundwater discharge. Water depth too shallow to implement.
Treatment	Monitored Natural Recovery	Relies on natural sediment deposition processes to cover contaminated sediment, thereby reducing site exposure risks.	Not effective as the relatively low stream flow and sediment deposition rate would take a substantial duration to isolate contaminated sediments.	Implementable	Medium-Low	No	Not effective for sediment in South Ditch due to relatively low stream flow and sediment deposition rate.

Table 2.3-2
Screening of Remedial Technologies – Sediment and Wetland Soil

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

General Response Action	Remediation Technology and Process Option	Description of Process Option	Effectiveness	Implementability	Cost	Retained	Screening Comments
Treatment (continued)	Enhanced Bioremediation	Relies on biological processes to reduce the toxicity, mobility, and volume of contaminants. Amendments and nutrients are added to soil to enhance/accelerate natural degradation processes.	Not effective for chromium or BEHP, the primary COCs in wetland soil and sediment.	Implementable	Medium-Low	No	Not effective for chromium or BEHP, which are primary COCs in wetland soil and sediment.
	Solidification/Stabilization	Relies on encapsulation of the waste through mixing with additives and binders to immobilize contaminants by converting them into less soluble, mobile, or toxic states.	Effective; if implementable	Difficult to implement in-situ due to small volume of soil and sediment, and presence of tree roots and vegetation. The additives and binders would increase the volume of sediment and surface soil, thereby changing the stream bed elevation and negatively affecting stream flow characteristics.	Medium	Yes	In-situ implementation could negatively affect stream configuration and flow characteristics. Ex-situ implementation was retained for further evaluation in conjunction with excavation and off-site disposal.
	Chemical Reduction/Oxidation	Reducing compounds or oxidizing chemicals are injected to enhance reduction/degradation or immobilization of contaminants.	Chemical reduction effective for inorganics (e.g., hexavalent chromium), but may be less effective for SVOCs such as BEHP, which is a primary COC.	Difficult to implement in surface soil and sediments.	Medium	No	Effective, but difficult to implement in surface soil and sediment. Hexavalent chromium is not a COC in soil and sediment being addressed. Oxidation to reduce organics would create hexavalent chromium from trivalent chromium.
Removal	Mechanical excavation	Excavation using conventional earthmoving equipment.	Effective. Interrupts direct exposure pathway and reduces erosion and leaching if combined with protective disposal option.	Implementable. Need to protect workers with HASP. Need to identify suitable disposal method.	Medium	Yes	Used in conjunction with treatment/disposal technologies.

Table 2.3-2
Screening of Remedial Technologies – Sediment and Wetland Soil

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

General Response Action	Remediation Technology and Process Option	Description of Process Option	Effectiveness	Implementability	Cost	Retained	Screening Comments
Disposal	<u>On-site Disposal</u>						
	Consolidate on-site and cap	Excavated material would be consolidated on site under a capping system.	Effective. Would require appropriate design to ensure cap stability on steep slopes. Capping interrupts direct exposure pathway and can be designed to prevent leaching and migration of contaminants.	Implementable; however, requires administrative controls and deed restrictions on future land use at site. Requires long-term monitoring and maintenance.	Medium-High	No	Construct and maintenance of an on-site disposal area would have negative impacts on the overall goal of site cleanup and redevelopment.
Disposal (continued)	<u>Off-Site Disposal</u>	Permitted landfill	Effective	Implementable	Medium	Yes	More cost-effective than on-site disposal, due to small volume of material, and design, construction, and maintenance of an on-site disposal area.

Prepared by: APP 12/13/2019
Checked by: JDW 04/02/2020

Notes:
BEHP = Bis(2-ethylhexyl)phthalate
COC = Chemical of Concern
EA = Exposure Area
HASP = Health and Safety Plan
HHRA = Human Health Risk Assessment
SVOC = Semivolatile Organic Compound
TMPs = Trimethylpentenes

Table 2.3-3
Screening of Remedial Technologies – Surface Water

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

General Response Action	Remediation Technology and Process Option	Description of Process Option	Effectiveness	Implementability	Cost	Retained	Screening Comments
No Action	None	No action taken	Not effective	Implementable	No Cost	Yes	Required for baseline comparison
Institutional Controls	<u>Access and Use Restrictions</u>						
	Notice of Activity and Use Limitations (NAULs)	Intended to prevent unacceptable exposures to contamination by identifying activities and uses that are consistent with maintaining a condition of No Significant Risk.	Effective, but not applicable to ecological receptors or for reducing ecological risks.	Implementable	Low	No	Not applicable to ecological receptors.
	<u>Environmental Monitoring</u>						
	Surface water sampling	Collection and analysis of surface water samples to aid in assessing potential exposure risks.	Effective	Implementable	Low	Yes	May be used in conjunction with other technologies
Removal							
	<u>Diversion/Extraction</u>	Surface water flow would be diverted and treated to remove COCs.	Effective	Implementable	Medium-High	No	Since groundwater discharge is the base flow for South Ditch, implementing this technology would eliminate the stream.
	<u>Stream Diversion</u>	Re-route the stream to a new channel along Ephemeral Drainage.	Ineffective. Rerouting the stream would not reduce COC concentrations.	Implementable	Medium	No	Not Effective.
	<u>Groundwater Extraction</u>	Extract contaminated groundwater prior to discharge to East Ditch and/or South Ditch.	Effective. Would remove the continuing source of contaminated ground water from East Ditch and/or South Ditch by extracting contaminated groundwater for ex-situ treatment.	Implementable.	High	Yes	May be used in conjunction with ex-situ treatment technologies.

Table 2.3-3
Screening of Remedial Technologies – Surface Water

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

General Response Action	Remediation Technology and Process Option	Description of Process Option	Effectiveness	Implementability	Cost	Retained	Screening Comments
Ex-Situ Treatment							
	New On-Site Groundwater Treatment Plant	Relies on new on-site groundwater treatment plant (to be installed as part of the Groundwater Remedial Alternatives presented in the IAFS.	Effective. New proposed groundwater treatment plant would include pretreatment, breakpoint chlorination, solids handling, and UV/oxidation to treat Site COCs in groundwater, including chromium, ammonia, and BEHP, the COCs associated with East Ditch and South Ditch surface water.	Implementable.	Medium-High	Yes	May be used in conjunction with groundwater extraction.
	Enhanced Bioremediation	Relies on amendments, nutrients, and/or microorganisms that are added to enhance biological degradation.	Not Effective. Bioremediation is not effective for inorganics (e.g., chromium) or ammonia, which are the primary COCs in East Ditch and South Ditch surface water.	Difficult to implement for the same reasons that it would be ineffective.	Medium-High	No	Not Effective.
	Chemical Reduction/Oxidation	Reducing compounds or oxidizing chemicals are added to enhance reduction/degradation or immobilization of contaminants.	Not Effective. Oxidation would increase toxicity and mobility of chromium.	Difficult to Implement	Medium	No	Not effective for chromium or ammonia. Oxidation would produce hexavalent chromium (which is currently not a COC), increasing overall toxicity and mobility.
	Chemical Adsorption	Diverted surface water is pumped through columns or tanks filled with sorbent materials to remove COCs.	Conditionally Effective. The technology is effective at reducing chromium and ammonia concentrations; however, if the continuing source of groundwater is not removed, this technology would be required indefinitely.	Implementable	High	No	Not retained as a technology for surface water, but would be a component of the new proposed groundwater treatment plant evaluated in the IAFS. See New On-Site Groundwater Treatment Plant listed above.
	Ultraviolet (UV) Oxidation	Strong oxidizers are added and media is irradiated by UV light to destroy organic compounds.	Effective for NDMA with pretreatment of other constituents. Not effective for chromium or ammonia.	Implementable	Medium-High	No	Not retained as a technology for surface water, but would be a component of the new proposed groundwater treatment plant evaluated in the IAFS. See New On-Site Groundwater Treatment Plant listed above.

Table 2.3-3
Screening of Remedial Technologies – Surface Water

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

General Response Action	Remediation Technology and Process Option	Description of Process Option	Effectiveness	Implementability	Cost	Retained	Screening Comments
Ex-Situ Treatment (continued)	<u>Break Point Chlorination</u>	Addition of chlorine to oxidize COCs.	Effective for ammonia in dilute solutions. Not effective for chromium.	Implementable	Medium	No	Not retained as a technology for surface water, but would be a component of the new proposed groundwater treatment plant evaluated in the IAFS. See New On-Site Groundwater Treatment Plant listed above.
In-Situ Treatment	<u>Permeable Reactive Barrier (PRB)</u>	A barrier created of reactive material such as ZVI and/or zeolites is placed downgradient of contamination to treat COCs as groundwater flows through the barrier, prior to discharge to South Ditch.	Effective	Implementable; however, groundwater discharges along the entire length of South Ditch. Installation of a PRB along the entire length of South Ditch would result in significant negative impacts to the wetlands in the vicinity of South Ditch.	Medium-High	Yes	Retained as a potentially viable technology for further evaluation.
	<u>Chemical Adsorption</u>	Relies on an adsorbent material to remove contaminants from the water. Activated carbon can be effective for chromium reduction/removal. Zeolites (hydrated aluminum-silicate minerals) have been found to be effective at removing ammonia from wastewaters.	Effective. A combination of adsorbent materials could be placed in South Ditch to allow surface water to flow through the adsorbent materials.	Difficult to implement due to contaminated groundwater discharge along the entire length of South Ditch. Periodic removal and replacement of adsorbent materials would be required and would be destructive to ecological habitat.	Medium	No	Technically feasible; however, periodic replacement of adsorbent materials over many decades would be destructive to ecological habitat.
Containment	<u>Subsurface Walls</u>	Create a subsurface boundary such as a slurry wall or grouted sheet pile wall between the continuing source of contaminated groundwater (OU3) and South Ditch.	Effective	Difficult Implementation	Medium	No	Unnecessarily disruptive to groundwater flow.

Prepared by: APP 12/13/2019
Checked by: JDW 04/02/2020

Notes:
COC = Chemical of Concern
IAFS = Interim Action Feasibility Study
NDMA = n-Nitrosodimethylamine
OU = Operable Unit
PRB = Permeable Reactive Barrie
ZVI = Zero Valent Iron

Table 4.2-1
Cost Estimate for Alternative TMP 2

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

NOTES

Cost estimate for Alternative TMP 2: Limited Action and Vapor Barrier/SSDS, and institutional controls for TMPs in soil.
Five-year reviews for 30 years
Year 0 = 2019
NPW based on 7% annual discount rate

CAPITAL COSTS

Description	Quantity	Units	Unit Cost	Extended Cost	Note
Design for SSDS & Vapor Barrier	1	LS	$18,300	$18,300	Assume 15% of installation cost
Installation of Vapor Barrier/SSDS	30,500	SF	$4	$122,000	ITRC 2008; NAVFAC 2011
Limited Action					
Deed Restriction Modification and ICs	0	LS	$12,400	$0	Performed internally by Olin
Contingency	0	%	20%	$24,400	
		TOTAL CAPITAL COSTS		$164,700	

ANNUAL COSTS YEARS 1 - 2

Description	Quantity	Units	Unit Cost	Extended Cost	Note
Vapor Barrier/SSDS	0	LS	$0	$0	
Limited Action and Monitoring					
Deed Restriction Modification and ICs	0	LS	$0	$0	Performed internally by Olin
		TOTAL ANNUAL COSTS		$0	Years 1 - 2

ANNUAL COSTS YEARS 3 - 5

Description	Quantity	Units	Unit Cost	Extended Cost	Note
Vapor Barrier/SSDS	0	LS	$0	$0	
Limited Action and Monitoring					
Deed Restriction Modification and ICs	0	LS	$0	$0	Performed internally by Olin
		TOTAL ANNUAL COSTS		$0	Years 3 - 5

5-YEAR PERIODIC COSTS

Description	Quantity	Units	Unit Cost	Extended Cost	Note
Vapor Barrier/SSDS	0	LS	$0	$0	
Limited Action and Monitoring					
Deed Restriction Modification and ICs	0	LS	$0	$0	Performed internally by Olin
Reporting					
5-Year Review Report	1	LS	$5,000	$5,000	Incremental cost only; will be performed site-wide
Deed Restrictions Verification and Maintenance	0	LS	$5,000	$0	Performed internally by Olin
		TOTAL 5-YEAR COSTS		$5,000	

Table 4.2-1
Cost Estimate for Alternative TMP 2

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

PRESENT VALUE ANALYSIS					
Cost Type	**Year**	**Total Cost**	**Discount Factor**	**Present Value**	**Note**
Capital Costs	0	$164,700	1.0000	$164,700	
Annual Costs	1	$0	0.9346	$0	
Annual Costs	2	$0	0.8734	$0	
Annual Costs	3	$0	0.8163	$0	
Annual Costs	4	$0	0.7629	$0	
Annual Costs	5	$0	0.7130	$0	
5-Year Periodic Costs	5	$5,000	0.7130	$3,565	
Annual Costs	6	$0	0.6663	$0	
Annual Costs	7	$0	0.6227	$0	
Annual Costs	8	$0	0.5820	$0	
Annual Costs	9	$0	0.5439	$0	
Annual Costs	10	$0	0.5083	$0	
5-Year Periodic Costs	10	$5,000	0.5083	$2,542	
Annual Costs	11	$0	0.4751	$0	
Annual Costs	12	$0	0.4440	$0	
Annual Costs	13	$0	0.4150	$0	
Annual Costs	14	$0	0.3878	$0	
Annual Costs	15	$0	0.3624	$0	
5-Year Periodic Costs	15	$5,000	0.3624	$1,812	
Annual Costs	16	$0	0.3387	$0	
Annual Costs	17	$0	0.3166	$0	
Annual Costs	18	$0	0.2959	$0	
Annual Costs	19	$0	0.2765	$0	
Annual Costs	20	$0	0.2584	$0	
5-Year Periodic Costs	20	$5,000	0.2584	$1,292	
Annual Costs	21	$0	0.2415	$0	
Annual Costs	22	$0	0.2257	$0	
Annual Costs	23	$0	0.2109	$0	
Annual Costs	24	$0	0.1971	$0	
Annual Costs	25	$0	0.1842	$0	
5-Year Periodic Costs	25	$5,000	0.1842	$921	
Annual Costs	26	$0	0.1722	$0	
Annual Costs	27	$0	0.1609	$0	
Annual Costs	28	$0	0.1504	$0	
Annual Costs	29	$0	0.1406	$0	
5-Year Periodic Costs	30	$5,000	0.1314	$657	
		$194,700		$175,489	
TOTAL COST OF ALTERNATIVE			**$195,000**		
TOTAL PRESENT WORTH OF ALTERNATIVE			**$175,000**		
PROJECT DURATION			**30 Years**		

Prepared/Date: APP 12/13/2019
Checked/Revised/Date: JDW 4/16/209

Interstate Technology and Regulatory Council (ITRC) 2008. Vapor Intrusion: A Practical Guide. ITRC, January 2007.
Naval Facilities Engineering Command (NAVFAC) 2011; Vapor Intrusion Mitigation in Construction of New Buildings Fact Sheet; NAVFAC Navy Alternative Restoration Technology Team, August 2011.

Table 4.2-2
Cost Estimate for Alternative TMP 3

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

NOTES

Cost estimate for Alternative TMP 3: AS/SVE for TMPs in soil. Alternative includes pre-design investigations, design, installation of AS and SVE wells and associated piping along with re-purposing the previously used treatment trailer and carbon vessels. Wells from the three remediation areas would be piped to the treatment trailer located near Plant B. Pre-design, design, system installation and startup to be approximately 1 year and 5 years of treatement system O&M, followed by post-remediation verification sampling and reporting in Year 6, and five-year site reviewsfor 30 years. Overall duration of this alternative is 30 years.

Year 0 = 2019
NPW based on 7% annual discount rate

CAPITAL COSTS

Description	Quantity	Units	Unit Cost	Extended Cost	Note
Pre-Design Investigation	1	LS	$10,000	$10,000	2-day drilling program & geophysical survey for utilities
Design AS/SVE System	1	LS	$52,167	$52,167	Assume 15% of installation cost
AS/SVE System					
Impermeable Surface Cover	7800	SF	$1	$7,878	Applied to unpaved surfaces
SVE Extraction Wells	25	EA	$5,000	$125,000	Based on similar projects
SVE Piping	1800	LF	$10	$18,702	Based on similar projects
AS Injection Wells	12	EA	$5,600	$67,200	Based on similar projects
AS Piping	1500	LF	$6	$9,000	Based on similar projects
Valves/Instrumentation	1	LS	$11,000	$11,000	Based on similar projects
System Upgrades	1	LS	$22,000	$22,000	Based on similar projects
Electrical Hookup	1	LS	$13,200	$13,200	Based on similar projects
System Startup and Testing	1	LS	$15,400	$15,400	Based on similar projects
Transportation and Disposal for IDW	22	Drum	$200	$4,400	Based on similar projects
Installation Oversight	44	Days	$1,000	$44,000	Based on similar projects
Remedial Action Report	1	LS	$10,000	$10,000	Based on similar projects
Contingency	0	%	20%	$69,600	
		TOTAL CAPITAL COSTS		$479,547	

ANNUAL COSTS YEARS 1 - 2

Description	Quantity	Units	Unit Cost	Extended Cost	Note
AS/SVE System					
Operator	832	Hours	$60	$49,920	Assume 1 operator at 16 hours per week
Semi-annual Groundwater/SW Sampling	1	LS	$10,000	$10,000	Based on similar projects
Annual Monitoring and Performance Report	1	LS	$10,000	$10,000	Includes AS/SVE Performance and SW Monitoring data; Based on costs for similar sites and reporting
		TOTAL ANNUAL COSTS		$69,920	Years 1 - 2

ANNUAL COSTS YEARS 3 - 5

Description	Quantity	Units	Unit Cost	Extended Cost	Note
AS/SVE System					
Operator	832	Hours	$60	$49,920	Assume 1 operator at 16 hours per week
Semi-annual Groundwater/SW Sampling	1	LS	$10,000	$10,000	
Annual Monitoring and Performance Report	1	LS	$10,000	$10,000	Based on similar projects
		TOTAL ANNUAL COSTS		$69,920	Years 3 - 5

ANNUAL COSTS YEAR 6

Description	Quantity	Units	Unit Cost	Extended Cost	Note
AS/SVE System					
Operator	0	Hours	$60	$0	Operate for first 5 years only
Annual Groundwater Sampling Event	0	LS	$10,000	$0	Only first 5 years
Post-Remediation Verification Investigation	1	LS	$25,000	$25,000	5-day drilling program; soil sampling & lab analysis
Annual Monitoring and Performance Report	1	LS	$10,000	$10,000	Based on similar projects
		TOTAL ANNUAL COSTS		$35,000	Year 6

Table 4.2-2
Cost Estimate for Alternative TMP 3

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

5-YEAR PERIODIC COSTS					
Description	**Quantity**	**Units**	**Unit Cost**	**Extended Cost**	**Note**
AS/SVE System					
Operator	0	Hours	$60	$0	Annual costs only; No 5-year costs
Annual Groundwater Sampling Event	0	LS	$10,000	$0	Annual costs only; No 5-year costs
Reporting					
5-Year Review Report	1	LS	$10,000	$10,000	Incremental cost only; will be performed site-wide
Deed Restrictions Verification and Maintenance	0	LS	$5,000	$0	Performed internally by Olin
		TOTAL 5-YEAR COSTS		$10,000	

PRESENT VALUE ANALYSIS					
Cost Type	**Year**	**Total Cost**	**Discount Factor**	**Present Value**	**Note**
Capital Costs	0	$479,547	1.0000	$479,547	
Annual Costs	1	$69,920	0.9346	$65,346	
Annual Costs	2	$69,920	0.8734	$61,071	
Annual Costs	3	$69,920	0.8163	$57,076	
Annual Costs	4	$69,920	0.7629	$53,342	
Annual Costs	5	$69,920	0.7130	$49,852	
5-Year Periodic Costs	5	$10,000	0.7130	$7,130	
Annual Costs	6	$35,000	0.6663	$23,322	
Annual Costs	7	$0	0.6227	$0	
Annual Costs	8	$0	0.5820	$0	
Annual Costs	9	$0	0.5439	$0	
Annual Costs	10	$0	0.5083	$0	
5-Year Periodic Costs	10	$10,000	0.5083	$5,083	
Annual Costs	11	$0	0.4751	$0	
Annual Costs	12	$0	0.4440	$0	
Annual Costs	13	$0	0.4150	$0	
Annual Costs	14	$0	0.3878	$0	
Annual Costs	15	$0	0.3624	$0	
5-Year Periodic Costs	10	$10,000	0.5083	$5,083	
Annual Costs	11	$0	0.4751	$0	
Annual Costs	12	$0	0.4440	$0	
Annual Costs	13	$0	0.4150	$0	
Annual Costs	14	$0	0.3878	$0	
Annual Costs	15	$0	0.3624	$0	
5-Year Periodic Costs	15	$10,000	0.3624	$3,624	
Annual Costs	16	$0	0.3387	$0	
Annual Costs	17	$0	0.3166	$0	
Annual Costs	18	$0	0.2959	$0	
Annual Costs	19	$0	0.2765	$0	
Annual Costs	20	$0	0.2584	$0	
5-Year Periodic Costs	20	$10,000	0.2584	$2,584	
Annual Costs	21	$0	0.2415	$0	
Annual Costs	22	$0	0.2257	$0	
Annual Costs	23	$0	0.2109	$0	
Annual Costs	24	$0	0.1971	$0	
Annual Costs	25	$0	0.1842	$0	
5-Year Periodic Costs	25	$10,000	0.1842	$1,842	
Annual Costs	26	$0	0.1722	$0	
Annual Costs	27	$0	0.1609	$0	
Annual Costs	28	$0	0.1504	$0	
Annual Costs	29	$0	0.1406	$0	
5-Year Periodic Costs	30	$10,000	0.1314	$1,314	
		$934,147		$816,216	
		TOTAL COST OF ALTERNATIVE	**$934,000**		
		TOTAL PRESENT WORTH OF ALTERNATIVE	**$816,000**		
		PROJECT DURATION	**30 Years**		

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Revised/Date: APP 12/30/2019

Table 4.2-3
Cost Estimate for Alternative TMP 4

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

NOTES

Cost estimate for Alternative TMP 4: In-Situ Thermal Treatment for TMPs
Steam Enhanced Extraction (SEE) in 3 soil areas; treat soil/groundwater @ ~7-17 ft bgs
Includes steam injection points (IPs) @ ~20-ft spacing and dual phase extraction wells (EWs) @ ~40 ft spacing
Three treatment areas piped to central treatment plant location
Treatment plant is temporary trailer and/or skid-mounted units
Post-remediation verification sampling
Pre-design & design @ 6 months, mobilization, system installation and O&M @ 12 months, and verification and reporting @ 6 months
Five-year reviews for 30 years
Year 0 = 2019
NPW based on 7% annual discount rate

Three Treatment Areas
Plant B & EA7 Area (23,000 SF)
EA3 Area (5,000 SF)
EA1 Lake Poly Area (2,500 SF)

CAPITAL COSTS

Description	Quantity	Units	Unit Cost	Extended Cost	Note
Institutional Controls					
Deed Restriction Modification	0	LS	$10,000	$0	Performed internally by Olin
Pre-Design Investigations	1	LS	$10,000	$10,000	2-day drilling program; additional soil characterization data
In-Situ Thermal Treatment System					Steam Enhanced Extraction
Design, Work Plan, HASP, Permit Assistance	1	LS	$139,900	$139,900	Estimate from Environmental Remediation Contractor
Materials Procurement and Mobilization	1	LS	$608,900	$608,900	Estimate from Environmental Remediation Contractor
Other Costs (Site Prep, IDW Disposal, electrical permitting and connection, energy consumption, carbon usage and regeneration, etc.)	1	LS	$1,028,700	$1,028,700	Estimate from Environmental Remediation Contractor
Subsurface Installation	1	LS	$464,100	$464,100	Estimate from Environmental Remediation Contractor
Plant B & EA7 Area (44 IPs; 21 EWs)					
EA3 Area (5 IPs; 5 EWs)					
EA1 Lake Poly Area (4 IPs; 4 EWs)					
Surface Installation and Start-up	1	LS	$585,900	$585,900	Estimate from Environmental Remediation Contractor
Demobilization	1	LS	$352,200	$352,200	Estimate from Environmental Remediation Contractor
Installation Oversight	104	Days	$1,000	$104,000	3 months construction, installation,and set-up and 1 month dismantle/demobe: full time oversight (5 days/week) 6 months treatment system operation: 1 day per week oversight
Contingency	0	%	20%	$658,700	
		TOTAL CAPITAL COSTS		$3,952,400	

ANNUAL COSTS YEAR 1

Description	Quantity	Units	Unit Cost	Extended Cost	Note
Remediation System Operation (6 months)	1	LS	$1,550,300	$1,550,300	5-day drilling program; soil sampling & lab analysis
System Monitoring and Performance Report	1	LS	$10,000	$10,000	Includes System Performance Monitoring data; Based on costs for similar sites and reporting
		TOTAL ANNUAL COSTS		$1,560,300	Year 1

ANNUAL COSTS YEAR 2

Description	Quantity	Units	Unit Cost	Extended Cost	Note
Post-Remediation Verification Investigation	1	LS	$25,000	$25,000	5-day drilling program; soil sampling & lab analysis
Remedial Action Report	1	LS	$10,000	$10,000	Based on costs for similar sites and reporting
		TOTAL ANNUAL COSTS		$35,000	Year 2

5-YEAR PERIODIC COSTS

Description	Quantity	Units	Unit Cost	Extended Cost	Note
Reporting					
5-Year Review Report	1	LS	$5,000	$5,000	Incremental cost only; will be performed site-wide
		TOTAL 5-YEAR COSTS		$5,000	

Table 4.2-3
Cost Estimate for Alternative TMP 4

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

PRESENT VALUE ANALYSIS					
Cost Type	**Year**	**Total Cost**	**Discount Factor**	**Present Value**	**Note**
Capital Costs	0	$3,952,400	1.0000	$3,952,400	
Annual Costs	1	$1,560,300	0.9346	$1,458,224	
Annual Costs	2	$35,000	0.8734	$30,570	
Annual Costs	3	$0	0.8163	$0	
Annual Costs	4	$0	0.7629	$0	
Annual Costs	5	$0	0.7130	$0	
5-Year Periodic Costs	5	$5,000	0.7130	$3,565	
Annual Costs	6	$0	0.6663	$0	
Annual Costs	7	$0	0.6227	$0	
Annual Costs	8	$0	0.5820	$0	
Annual Costs	9	$0	0.5439	$0	
Annual Costs	10	$0	0.5083	$0	
5-Year Periodic Costs	10	$5,000	0.5083	$2,542	
Annual Costs	11	$0	0.4751	$0	
Annual Costs	12	$0	0.4440	$0	
Annual Costs	13	$0	0.4150	$0	
Annual Costs	14	$0	0.3878	$0	
Annual Costs	15	$0	0.3624	$0	
5-Year Periodic Costs	15	$5,000	0.3624	$1,812	
Annual Costs	16	$0	0.3387	$0	
Annual Costs	17	$0	0.3166	$0	
Annual Costs	18	$0	0.2959	$0	
Annual Costs	19	$0	0.2765	$0	
Annual Costs	20	$0	0.2584	$0	
5-Year Periodic Costs	20	$5,000	0.2584	$1,292	
Annual Costs	21	$0	0.2415	$0	
Annual Costs	22	$0	0.2257	$0	
Annual Costs	23	$0	0.2109	$0	
Annual Costs	24	$0	0.1971	$0	
Annual Costs	25	$0	0.1842	$0	
5-Year Periodic Costs	25	$5,000	0.1842	$921	
Annual Costs	26	$0	0.1722	$0	
Annual Costs	27	$0	0.1609	$0	
Annual Costs	28	$0	0.1504	$0	
Annual Costs	29	$0	0.1406	$0	
5-Year Periodic Costs	30	$5,000	0.1314	$657	
		$5,577,700		$5,451,984	
	TOTAL COST OF ALTERNATIVE		**$5,578,000**		
	TOTAL PRESENT WORTH OF ALTERNATIVE		**$5,452,000**		
	PROJECT DURATION		**30 Years**		

Prepared/Date: APP 12/13/2019
Checked/Date: JDW 12/20/2019
Revised/Date: APP 12/30/2019

Table 4.2-4
Cost Estimate for Alternative TMP 5

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

NOTES

Cost estimate for Alternative TMP 5: Excavation and Off-Site Disposal of TMP Impacted Soil
Excavate 3 soil areas 0-12 ft bgs; 0-7 ft tested and assumed reused as backfill; 7-12 ft smear zone stabilized and shipped off-site for disposal as non-hazardous waste
Excavation/soil handling conducted inside temporary fabric structure w/ air treatment unit; also Level C PPE
Excavation dewatering; temporary water treatment unit; on-site discharge to surface water
Backfill to grade
Pre-design & design @ 3 months, on-site activites @ 4 months, and verification and reporting @ 4 months
Five-year reviews for 30 years
Year 0 = 2019
NPW based on 7% annual discount rate

CAPITAL COSTS

Description	Quantity	Units	Unit Cost	Extended Cost	Note
Institutional Controls					
Deed Restriction Modification	0	LS	$10,000	$0	Performed internally by Olin
Excavation and Off-Site Disposal					
Pre-Design Investigation	1	LS	$10,000	$10,000	3-day drilling program; additional soil characterization data
Pre-Excavation Wetland Survey	1	LS	$1,000	$1,000	Wetland Scientist; 1 day field effort
Wetland Restoration Plan	1	LS	$5,000	$5,000	Based on cost for similar effort
Excavation Design & Specification	1	LS	$256,985	$256,984.84	Assume 8% of implementation cost
Excavation Implementation					
Mobilization	1	LS	$74,403	$74,403	Estimate from Environmental Remediation Contractor
Site Staging and Prep *Includes temporary staging area for dewatering and erosion & sediment control*	1	LS	$72,201	$72,201	Estimate from Environmental Remediation Contractor
Sheet Pile Wall at EA3	3000	SF	$50	$150,000	Estimate from Environmental Remediation Contractor
Excavation	13555	CY	$ 20.34	$275,709	Estimate from Environmental Remediation Contractor
Excavation Dewatering	1	LS	$293,957	$293,957	Estimate from Environmental Remediation Contractor
Soil Dewatering/Stabilization	1	LS	$232,918	$232,918	Estimate from Environmental Remediation Contractor
Temporary Fabric Structure w/ Air Treatment	1	LS	$457,388	$457,388	Estimate from Environmental Remediation Contractor
Transportation and Disposal (Non-hazardous)	10000	Tons	$ 103.41	$1,034,100	Estimate from Environmental Remediation Contractor
Backfill and Restoration	14120	CY	$ 29.63	$418,376	Estimate from Environmental Remediation Contractor
Demobilization	1	LS	$74,261	$74,260	Estimate from Environmental Remediation Contractor
Excavation Verification Sampling & Analysis	1	LS	$9,000	$9,000	20'x20' grid; 90 samples (w/QC)
Remedial Action Oversight	120	Days	$1,000	$120,000	4 months on-site activities
Post Excavation					
Excavation Area Monthly Inspections	4	LS	$800	$3,200	Monthly for 4 months
Remedial Action Report	1	LS	$10,000	$10,000	Based on cost for similar effort
Contingency	0	%	20%	$699,700	
		TOTAL CAPITAL COSTS		$4,198,195	

5-YEAR PERIODIC COSTS

Description	Quantity	Units	Unit Cost	Extended Cost	Note
Reporting					
5-Year Review Report	1	LS	$5,000	$5,000	Incremental cost only; will be performed site-wide
		TOTAL 5-YEAR COSTS		$5,000	

Table 4.2-4
Cost Estimate for Alternative TMP 5

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

PRESENT VALUE ANALYSIS					
Cost Type	**Year**	**Total Cost**	**Discount Factor**	**Present Value**	**Note**
Capital Costs	0	$4,198,195	1.0000	$4,198,195	
Annual Costs	1	$0	0.9346	$0	
Annual Costs	2	$0	0.8734	$0	
Annual Costs	3	$0	0.8163	$0	
Annual Costs	4	$0	0.7629	$0	
Annual Costs	5	$0	0.7130	$0	
5-Year Periodic Costs	5	$5,000	0.7130	$3,565	
Annual Costs	6	$0	0.6663	$0	
Annual Costs	7	$0	0.6227	$0	
Annual Costs	8	$0	0.5820	$0	
Annual Costs	9	$0	0.5439	$0	
Annual Costs	10	$0	0.5083	$0	
5-Year Periodic Costs	10	$5,000	0.5083	$2,542	
Annual Costs	11	$0	0.4751	$0	
Annual Costs	12	$0	0.4440	$0	
Annual Costs	13	$0	0.4150	$0	
Annual Costs	14	$0	0.3878	$0	
Annual Costs	15	$0	0.3624	$0	
5-Year Periodic Costs	15	$5,000	0.3624	$1,812	
Annual Costs	16	$0	0.3387	$0	
Annual Costs	17	$0	0.3166	$0	
Annual Costs	18	$0	0.2959	$0	
Annual Costs	19	$0	0.2765	$0	
Annual Costs	20	$0	0.2584	$0	
5-Year Periodic Costs	20	$5,000	0.2584	$1,292	
Annual Costs	21	$0	0.2415	$0	
Annual Costs	22	$0	0.2257	$0	
Annual Costs	23	$0	0.2109	$0	
Annual Costs	24	$0	0.1971	$0	
Annual Costs	25	$0	0.1842	$0	
5-Year Periodic Costs	25	$5,000	0.1842	$921	
Annual Costs	26	$0	0.1722	$0	
Annual Costs	27	$0	0.1609	$0	
Annual Costs	28	$0	0.1504	$0	
Annual Costs	29	$0	0.1406	$0	
5-Year Periodic Costs	30	$5,000	0.1314	$657	
		$4,228,195		$4,208,984	
	TOTAL COST OF ALTERNATIVE		**$4,228,000**		
	TOTAL PRESENT WORTH OF ALTERNATIVE		**$4,209,000**		
	PROJECT DURATION		**30 Years**		

Prepared/Date: APP 12/13/2019
Checked/Date: JDW 12/20/2019
Revised/Date: APP 12/30/2019

Table 4.3-1
Cost Estimate for Alternative Soil 2

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

NOTES

Cost estimate for Alternative Soil 2: Cover System
Cover impacted areas with 12 inches of soil in soil areas, and 3" of Asphalt in asphalt areas
Pre-design & design @ 10 months, on-site activites @ 4 months, and reporting (RA report and SMP) @ 5 months
Five-year reviews for 30 years
Year 0 = 2020

CAPITAL COSTS

Description	Quantity	Units	Unit Cost	Extended Cost	Note
Institutional Controls					
Deed Restriction Modification	0	LS	$10,000	$0	Performed internally by Olin
Pre-Design Investigation and Design					
Pre-Design Investigation	1	LS	$20,000	$20,000	5-day drilling program; top foot only
Pre-Excavation Wetland Survey	1	LS	$1,000	$1,000	Wetland Scientist; 1 day field effort
Wetland Restoration Plan	1	LS	$5,000	$5,000	Based on cost for similar effort
Excavation Design & Specification	1	LS	$26,580	$26,580	Assume 8% of implementation cost
Excavation Implementation					
Mobilization	1	LS	$20,000	$20,000	No excavation equipment required
Site Staging and Prep *Includes temporary staging areas and erosion & sediment control*	1	LS	$30,000	$30,000	No impacted soil stockpiles required
Place and Grade Cover Soil	900	CY	$ 29.63	$26,667	In areas that existing surface is soil
Asphalt Pavement	38500	SF	$ 3.00	$115,500	Based on cost for similar effort
Demobilization	1	LS	$20,000	$20,000	Estimate from Environmental Remediation Contractor
Remedial Action Oversight	120	Days	$1,000	$120,000	4 months on-site activities
Post Remedy					
Covered Areas Monthly Inspections	4	LS	$800	$3,200	Inspect for settling, monthly for 4 months
Remedial Action Report	1	LS	$10,000	$10,000	Based on cost for similar effort
Soil Management and Site Maintenance Plan	1	LS	$10,000	$10,000	Based on cost for similar effort
Contingency	0	%	20%	$81,600	
		TOTAL CAPITAL COSTS		$489,547	

5-YEAR PERIODIC COSTS

Description	Quantity	Units	Unit Cost	Extended Cost	Note
Reporting & Maintenance					
5-Year Review Report	1	LS	$5,000	$5,000	Incremental cost only; will be performed site-wide
Soil and Asphalt Cover Repair	1	LS	$10,000	$10,000	Assume 50% of Asphalt requires re-sealing, an minor erosion
		TOTAL 5-YEAR COSTS		$15,000	

Table 4.3-1
Cost Estimate for Alternative Soil 2

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

PRESENT VALUE ANALYSIS					
Cost Type	**Year**	**Total Cost**	**Discount Factor**	**Present Value**	**Note**
Capital Costs	0	$489,547	1.0000	$489,547	
Annual Costs	1	$0	0.9346	$0	
Annual Costs	2	$0	0.8734	$0	
Annual Costs	3	$0	0.8163	$0	
Annual Costs	4	$0	0.7629	$0	
Annual Costs	5	$0	0.7130	$0	
5-Year Periodic Costs	5	$15,000	0.7130	$10,695	
Annual Costs	6	$0	0.6663	$0	
Annual Costs	7	$0	0.6227	$0	
Annual Costs	8	$0	0.5820	$0	
Annual Costs	9	$0	0.5439	$0	
Annual Costs	10	$0	0.5083	$0	
5-Year Periodic Costs	10	$15,000	0.5083	$7,625	
Annual Costs	11	$0	0.4751	$0	
Annual Costs	12	$0	0.4440	$0	
Annual Costs	13	$0	0.4150	$0	
Annual Costs	14	$0	0.3878	$0	
Annual Costs	15	$0	0.3624	$0	
5-Year Periodic Costs	15	$15,000	0.3624	$5,437	
Annual Costs	16	$0	0.3387	$0	
Annual Costs	17	$0	0.3166	$0	
Annual Costs	18	$0	0.2959	$0	
Annual Costs	19	$0	0.2765	$0	
Annual Costs	20	$0	0.2584	$0	
5-Year Periodic Costs	20	$15,000	0.2584	$3,876	
Annual Costs	21	$0	0.2415	$0	
Annual Costs	22	$0	0.2257	$0	
Annual Costs	23	$0	0.2109	$0	
Annual Costs	24	$0	0.1971	$0	
Annual Costs	25	$0	0.1842	$0	
5-Year Periodic Costs	25	$15,000	0.1842	$2,764	
Annual Costs	26	$0	0.1722	$0	
Annual Costs	27	$0	0.1609	$0	
Annual Costs	28	$0	0.1504	$0	
Annual Costs	29	$0	0.1406	$0	
5-Year Periodic Costs	30	$15,000	0.1314	$1,971	
		$579,547		$521,914	
		TOTAL COST OF ALTERNATIVE	**$580,000**		
		TOTAL PRESENT WORTH OF ALTERNATIVE	**$522,000**		
		PROJECT DURATION	**30 Years**		

Prepared/Date: JDW 01/16/2020
Checked/Date: LTB 04/02/2020

Table 4.3-2
Cost Estimate for Alternative Soil 3

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

NOTES

Cost estimate for Alternative Soil 3: Excavation (0-1') and Conver System
Excavate 1 foot deep in areas with impacts from 0-1 feet.
Stockpile, load and transport off-site for disposal.
Backfill to grade with soil in soil areas, and upper 3" with Asphalt in asphalt areas
Pre-design & design @ 11 months, on-site activites @ 5 months, and reporting (RA report and SMP) @ 6 months
Five-year reviews for 30 years
Year 0 = 2020

CAPITAL COSTS

Description	Quantity	Units	Unit Cost	Extended Cost	Note
Institutional Controls					
Deed Restriction Modification	0	LS	$10,000	$0	Performed internally by Olin
Pre-Design Investigation and Design					
Pre-Design Investigation	1	LS	$20,000	$20,000	5-day drilling program; top foot only
Pre-Excavation Wetland Survey	1	LS	$1,000	$1,000	Wetland Scientist; 1 day field effort
Wetland Restoration Plan	1	LS	$5,000	$5,000	Based on cost for similar effort
Excavation Design & Specification	1	LS	$73,320	$73,320	Assume 8% of implementation cost
Excavation Implementation					
Mobilization	1	LS	$37,000	$37,000	Half the price of full excavation
Site Staging and Prep *Includes temporary staging areas and erosion & sediment control*	1	LS	$36,000	$36,000	Half the price of full excavation
Excavation (in Level D)	2400	CY	$ 15.26	$36,624	
Transportation and Disposal (Hazardous)	385	Tons	$ 215.00	$82,775	Estimate from Environmental Remediation Contractor
Transportation and Disposal (Non-hazardous)	3460	Tons	$ 103.41	$357,799	Estimate from Environmental Remediation Contractor
Backfill and Grading	2150	CY	$ 29.63	$63,705	Leaves 3" open in asphalt areas
Asphalt Pavement	38500	SF	$ 3.00	$115,500	Based on cost for similar effort
Demobilization	1	LS	$37,000	$37,000	Estimate from Environmental Remediation Contractor
Remedial Action Oversight	150	Days	$1,000	$150,000	5 months on-site activities
Post Excavation					
Excavation Area Monthly Inspections	4	LS	$800	$3,200	Inspect for settling, monthly for 4 months
Remedial Action Report	1	LS	$10,000	$10,000	Based on cost for similar effort
Soil Management and Site Maintenance Plan	1	LS	$10,000	$10,000	Based on cost for similar effort
Contingency	0	%	20%	$207,800	
		TOTAL CAPITAL COSTS		$1,246,722	

5-YEAR PERIODIC COSTS

Description	Quantity	Units	Unit Cost	Extended Cost	Note
Reporting & Maintenance					
5-Year Review Report	1	LS	$5,000	$5,000	Incremental cost only; will be performed site-wide
Soil and Asphalt Cover Repair	1	LS	$10,000	$10,000	Assume 50% of Asphalt requires re-sealing, an minor erosion
		TOTAL 5-YEAR COSTS		$15,000	

Table 4.3-2
Cost Estimate for Alternative Soil 3

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

PRESENT VALUE ANALYSIS					
Cost Type	**Year**	**Total Cost**	**Discount Factor**	**Present Value**	**Note**
Capital Costs	0	$1,246,722	1.0000	$1,246,722	
Annual Costs	1	$0	0.9346	$0	
Annual Costs	2	$0	0.8734	$0	
Annual Costs	3	$0	0.8163	$0	
Annual Costs	4	$0	0.7629	$0	
Annual Costs	5	$0	0.7130	$0	
5-Year Periodic Costs	5	$15,000	0.7130	$10,695	
Annual Costs	6	$0	0.6663	$0	
Annual Costs	7	$0	0.6227	$0	
Annual Costs	8	$0	0.5820	$0	
Annual Costs	9	$0	0.5439	$0	
Annual Costs	10	$0	0.5083	$0	
5-Year Periodic Costs	10	$15,000	0.5083	$7,625	
Annual Costs	11	$0	0.4751	$0	
Annual Costs	12	$0	0.4440	$0	
Annual Costs	13	$0	0.4150	$0	
Annual Costs	14	$0	0.3878	$0	
Annual Costs	15	$0	0.3624	$0	
5-Year Periodic Costs	15	$15,000	0.3624	$5,437	
Annual Costs	16	$0	0.3387	$0	
Annual Costs	17	$0	0.3166	$0	
Annual Costs	18	$0	0.2959	$0	
Annual Costs	19	$0	0.2765	$0	
Annual Costs	20	$0	0.2584	$0	
5-Year Periodic Costs	20	$15,000	0.2584	$3,876	
Annual Costs	21	$0	0.2415	$0	
Annual Costs	22	$0	0.2257	$0	
Annual Costs	23	$0	0.2109	$0	
Annual Costs	24	$0	0.1971	$0	
Annual Costs	25	$0	0.1842	$0	
5-Year Periodic Costs	25	$15,000	0.1842	$2,764	
Annual Costs	26	$0	0.1722	$0	
Annual Costs	27	$0	0.1609	$0	
Annual Costs	28	$0	0.1504	$0	
Annual Costs	29	$0	0.1406	$0	
5-Year Periodic Costs	30	$15,000	0.1314	$1,971	
		$1,336,722		$1,279,089	
		TOTAL COST OF ALTERNATIVE	**$1,337,000**		
		TOTAL PRESENT WORTH OF ALTERNATIVE	**$1,279,000**		
		PROJECT DURATION	**30 Years**		

Prepared/Date: JDW 01/16/2020
Checked/Date: LTB 04/02/2020

Table 4.3-3
Cost Estimate for Alternative Soil 4

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

NOTES

Cost estimate for Alternative Soil 4: Excavation (0-10') and Off-Site Disposal
Excavate 11 deep areas. Average Depth of 9 feet for cost estimating purposes. Excavate shallow areas that extend beyond the deep areas to 1 foot.
Excavation, stockpile, load and transport off-site for disposal.
Excavation dewatering; temporary water treatment unit; on-site discharge to surface water
Backfill to grade
Pre-design & design @ 14 months, on-site activites @ 6 months, and verification and reporting @ 4 months
Five-year reviews for 30 years
Year 0 = 2020

CAPITAL COSTS

Description	Quantity	Units	Unit Cost	Extended Cost	Note
Institutional Controls					
Deed Restriction Modification	0	LS	$10,000	$0	Performed internally by Olin
Pre-Design Investigation and Design					
Pre-Design Investigation	1	LS	$40,000	$40,000	10-day drilling program; additional soil characterization data
Pre-Excavation Wetland Survey	1	LS	$1,000	$1,000	Wetland Scientist; 1 day field effort
Wetland Restoration Plan	1	LS	$5,000	$5,000	Based on cost for similar effort
Excavation Design & Specification	1	LS	$802,509	$802,509.31	Assume 8% of implementation cost
Excavation Implementation					
Mobilization	1	LS	$74,403	$74,403	Estimate from Environmental Remediation Contractor
Site Staging and Prep *Includes temporary staging area for dewatering and erosion & sediment control*	1	LS	$72,201	$72,201	Estimate from Environmental Remediation Contractor
Sheet Pile Wall at EA3	3300	SF	$50	$165,000	Estimate from Environmental Remediation Contractor
Excavation (in Level C)	13555	CY	$ 20.34	$275,709	Applicable to TMP Areas
Excavation (in Level D)	21445	CY	$ 15.26	$327,143	
Excavation Dewatering	1	LS	$293,957	$293,957	Estimate from Environmental Remediation Contractor
Soil Dewatering/Stabilization	1	LS	$232,918	$232,918	Estimate from Environmental Remediation Contractor
Temporary Fabric Structure w/ Air Treatment	1	LS	$457,388	$457,388	Applicable to TMP Areas
Transportation and Disposal (Hazardous)	5600	Tons	$ 215.00	$1,204,000	Estimate from Environmental Remediation Contractor
Transportation and Disposal (Non-hazardous)	51800	Tons	$ 103.41	$5,356,638	Estimate from Environmental Remediation Contractor
Backfill and Grading	35000	CY	$ 29.63	$1,037,050	Estimate from Environmental Remediation Contractor
Asphalt Pavement	68500	SF	$ 3.00	$205,500	Based on cost for similar effort
Demobilization	1	LS	$74,261	$74,260	Estimate from Environmental Remediation Contractor
Excavation Verification Sampling & Analysis	320	EA	$235	$75,200	20'x20' grid; 320 samples (w/QC), BEHP, Cr, TMP
Remedial Action Oversight	180	Days	$1,000	$180,000	6 months on-site activities
Post Excavation					
Excavation Area Monthly Inspections	4	LS	$800	$3,200	Inspect for settling, monthly for 4 months
Remedial Action Report	1	LS	$10,000	$10,000	Based on cost for similar effort
Contingency	0	%	20%	$2,178,600	
		TOTAL CAPITAL COSTS		$13,071,676	

5-YEAR PERIODIC COSTS

Description	Quantity	Units	Unit Cost	Extended Cost	Note
Reporting					
5-Year Review Report	1	LS	$5,000	$5,000	Incremental cost only; will be performed site-wide
		TOTAL 5-YEAR COSTS		$5,000	

Table 4.3-3
Cost Estimate for Alternative Soil 4

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

PRESENT VALUE ANALYSIS					
Cost Type	**Year**	**Total Cost**	**Discount Factor**	**Present Value**	**Note**
Capital Costs	0	$13,071,676	1.0000	$13,071,676	
Annual Costs	1	$0	0.9346	$0	
Annual Costs	2	$0	0.8734	$0	
Annual Costs	3	$0	0.8163	$0	
Annual Costs	4	$0	0.7629	$0	
Annual Costs	5	$0	0.7130	$0	
5-Year Periodic Costs	5	$5,000	0.7130	$3,565	
Annual Costs	6	$0	0.6663	$0	
Annual Costs	7	$0	0.6227	$0	
Annual Costs	8	$0	0.5820	$0	
Annual Costs	9	$0	0.5439	$0	
Annual Costs	10	$0	0.5083	$0	
5-Year Periodic Costs	10	$5,000	0.5083	$2,542	
Annual Costs	11	$0	0.4751	$0	
Annual Costs	12	$0	0.4440	$0	
Annual Costs	13	$0	0.4150	$0	
Annual Costs	14	$0	0.3878	$0	
Annual Costs	15	$0	0.3624	$0	
5-Year Periodic Costs	15	$5,000	0.3624	$1,812	
Annual Costs	16	$0	0.3387	$0	
Annual Costs	17	$0	0.3166	$0	
Annual Costs	18	$0	0.2959	$0	
Annual Costs	19	$0	0.2765	$0	
Annual Costs	20	$0	0.2584	$0	
5-Year Periodic Costs	20	$5,000	0.2584	$1,292	
Annual Costs	21	$0	0.2415	$0	
Annual Costs	22	$0	0.2257	$0	
Annual Costs	23	$0	0.2109	$0	
Annual Costs	24	$0	0.1971	$0	
Annual Costs	25	$0	0.1842	$0	
5-Year Periodic Costs	25	$5,000	0.1842	$921	
Annual Costs	26	$0	0.1722	$0	
Annual Costs	27	$0	0.1609	$0	
Annual Costs	28	$0	0.1504	$0	
Annual Costs	29	$0	0.1406	$0	
5-Year Periodic Costs	30	$5,000	0.1314	$657	
		$13,101,676		$13,082,465	
	TOTAL COST OF ALTERNATIVE		**$13,102,000**		
	TOTAL PRESENT WORTH OF ALTERNATIVE		**$13,082,000**		
	PROJECT DURATION		**30 Years**		

Prepared/Date: JDW 01/16/2020
Checked/Date: LTB 04/02/2020

Table 4.4-1
Cost Estimate for Alternative WSS 2

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

NOTES

Cost estimate for Alternative WSS 2: Excavation and Off-Site Disposal. Alternative includes pre-design investigations and design, temporary storm water diversion, excavation of sediment and surface soil, stabilization of excavated material, off-site disposal of excavated material, backfilling and re-grading of the excavated areas, wetland restoration, reporting, and five-year reviews. The duration of pre-design invesitgation, design, execution of the remedy and reporting is approximately 22 months. Five-year reviews would be conducted for 30 years.

Year 0 = 2020

CAPITAL COSTS

Description	Quantity	Units	Unit Cost	Extended Cost	Note
Institutional Controls					
Deed Restriction Modification	0	LS	$10,000	$0	Performed internally by Olin
Pre-Design Investigation and Design					
Pre-Design Investigation	1	LS	$16,150	$16,150	30 soil/sediment locations; pre-excavation characterization
Pre-Excavation Wetland Survey	1	LS	$1,000	$1,000	Wetland Scientist; 1 day field effort
Permitting Coordination	1	LS	$10,000	$10,000	Based on cost for similar effort
Wetland Restoration Plan	1	LS	$5,000	$5,000	Based on cost for similar effort
Remedial Action Work Plan / Design	1	LS	$129,591	$129,591	Assume 8% of implementation cost
Excavation and Off-Site Disposal					
Mobilization	1	LS	$37,000	$37,000	Estimate from Environmental Remediation Contractor
Site Staging and Prep *Includes temporary staging area for dewatering, silt fencing, tree removal, and matting for access*	1	LS	$95,300	$95,300	Estimate from Environmental Remediation Contractor
Haul Road Construction	1	LS	$30,600	$30,600	Estimate from Environmental Remediation Contractor
Surface Water/Stormwater Diversion	550	LF	$100	$55,000	Estimate from Environmental Remediation Contractor
Pond and Ditch Dewatering Equipment	1	LS	$30,200	$30,200	Based on cost for similar effort
Dewatering Boxes	1	LS	$15,000	$15,000	Based on cost for similar effort
Excavation (in-place volume)	4000	CY	$ 75.00	$300,000	Estimate from Environmental Remediation Contractor
SoilStabilization (loose volume)	5000	CY	$33	$166,350	
Transportation and Disposal (Non-hazardous)	6200	Tons	$ 103.41	$641,142	Estimate from Environmental Remediation Contractor
Backfill and Restoration	5000	CY	$ 40.00	$200,000	Estimate from Environmental Remediation Contractor
Restoration Plantings	1	LS	$7,500	$7,500	Estimate from Environmental Remediation Contractor
Demobilization	1	LS	$37,000	$37,000	Estimate from Environmental Remediation Contractor
Excavation Area Monthly Inspections	6	LS	$800	$4,800	Monthly for 6 months
Remedial Action Oversight	150	Days	$1,000	$150,000	Oversight for 5 months
Remedial Action Report	1	LS	$10,000	$10,000	Based on cost for similar effort
Soil Management Plan	1	LS	$10,000	$10,000	Based on cost for similar effort
Contingency	0	%	20%	$390,300	
		TOTAL CAPITAL COSTS		$2,341,933	

ANNUAL COSTS YEARS 1 - 2

Description	Quantity	Units	Unit Cost	Extended Cost	Note
Ecological Recovery Inspection (Semi-Annual)	2	Each	$800	$1,600	Based on cost for similar effort
Annual Monitoring and Performance Report	1	LS	$5,000	$5,000	Based on costs for similar sites and reporting
		TOTAL ANNUAL COSTS		$6,600	Years 1 - 2

ANNUAL COSTS YEARS 3 - 30

Description	Quantity	Units	Unit Cost	Extended Cost	Note
Ecological Recovery Inspection (Semi-Annual)	1	Each	$800	$800	Based on cost for similar effort
Annual Monitoring and Performance Report	1	LS	$5,000	$5,000	Based on costs for similar sites and reporting
		TOTAL ANNUAL COSTS		$5,800	Years 3 - 30

5-YEAR PERIODIC COSTS

Description	Quantity	Units	Unit Cost	Extended Cost	Note
Ecological Recovery Inspection	1	Each	$800	$800	Based on cost for similar effort
Reporting					
5-Year Review Report	1	LS	$10,000	$10,000	Incremental cost only; will be performed site-wide
Deed Restrictions Verification and Maintenance	0	LS	$5,000	$0	Performed internally by Olin
		TOTAL 5-YEAR COSTS		$10,800	

Table 4.4-1
Cost Estimate for Alternative WSS 2

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

PRESENT VALUE ANALYSIS					
Cost Type	**Year**	**Total Cost**	**Discount Factor**	**Present Value**	**Note**
Capital Costs	0	$2,341,933	1.0000	$2,341,933	
Annual Costs	1	$6,600	0.9346	$6,168	
Annual Costs	2	$6,600	0.8734	$5,765	
Annual Costs	3	$5,800	0.8163	$4,735	
Annual Costs	4	$5,800	0.7629	$4,425	
Annual Costs	5	$5,800	0.7130	$4,135	
5-Year Periodic Costs	5	$10,800	0.7130	$7,700	
Annual Costs	6	$5,800	0.6663	$3,865	
Annual Costs	7	$5,800	0.6227	$3,612	
Annual Costs	8	$5,800	0.5820	$3,376	
Annual Costs	9	$5,800	0.5439	$3,155	
Annual Costs	10	$5,800	0.5083	$2,948	
5-Year Periodic Costs	10	$10,800	0.5083	$5,490	
Annual Costs	11	$5,800	0.4751	$2,756	
Annual Costs	12	$5,800	0.4440	$2,575	
Annual Costs	13	$5,800	0.4150	$2,407	
Annual Costs	14	$5,800	0.3878	$2,249	
Annual Costs	15	$5,800	0.3624	$2,102	
5-Year Periodic Costs	15	$10,800	0.3624	$3,914	
Annual Costs	16	$5,800	0.3387	$1,965	
Annual Costs	17	$5,800	0.3166	$1,836	
Annual Costs	18	$5,800	0.2959	$1,716	
Annual Costs	19	$5,800	0.2765	$1,604	
Annual Costs	20	$5,800	0.2584	$1,499	
5-Year Periodic Costs	20	$10,800	0.2584	$2,791	
Annual Costs	21	$5,800	0.2415	$1,401	
Annual Costs	22	$5,800	0.2257	$1,309	
Annual Costs	23	$5,800	0.2109	$1,223	
Annual Costs	24	$5,800	0.1971	$1,143	
Annual Costs	25	$5,800	0.1842	$1,069	
5-Year Periodic Costs	25	$10,800	0.1842	$1,990	
Annual Costs	26	$5,800	0.1722	$999	
Annual Costs	27	$5,800	0.1609	$933	
Annual Costs	28	$5,800	0.1504	$872	
Annual Costs	29	$5,800	0.1406	$815	
Annual Costs	30	$5,800	0.1314	$762	
5-Year Periodic Costs	30	$10,800	0.1314	$1,419	
		$2,582,333		$2,438,657	
TOTAL COST OF ALTERNATIVE			**$2,582,000**		
TOTAL PRESENT WORTH OF ALTERNATIVE			**$2,439,000**		
PROJECT DURATION			**30 Years**		

Prepared/Date: JMP 01/16/2020
Checked/Date: JDW 1/21/2020

Table 4.5-1
Cost Estimate for Alternative SW 2

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

NOTES

This alternative (SW 2) includes long-term monitoring of 7 surface water locations and 22 groundwater monitoring wells on a semi-annual basis.
Monitoring is assumed for 30 years. Monitoring is assumed to include ammonia, NDMA, sulfate, and metals (i.e., aluminum, chromium, iron, lead, and zinc).

Base Year (Year 0) = 2019

CAPITAL COSTS

Description	Quantity	Units	Unit Cost	Extended Cost	Note
		TOTAL CAPITAL COSTS		$0	

ANNUAL COSTS

Description	Quantity	Units	Unit Cost	Extended Cost	Note
Semi-Annual Groundwater and Surface Water Monitoring	2	Events	$32,450	$64,900	Based on Similar Efforts - 29 sampling locations
Monitoring Report	1	LS	$15,000	$15,000	Based on Similar Projects
		TOTAL ANNUAL COSTS		$79,900	

5-YEAR PERIODIC COSTS

Description	Quantity	Units	Unit Cost	Extended Cost	Note
5-Year Review Report	1	LS	$5,000	$5,000	Incremental Costs Only - Will be performed site-wide
Deed Restrictions Verification and Maintenance	0	LS	$5,000	$0	N/A - Performed Internally to Olin
	TOTAL 5-YEAR PERIODIC COSTS			$5,000	

PRESENT VALUE ANALYSIS

Cost Type	Year	Total Cost	Discount Factor	Present Value	Note
Capital Costs	0	$0	1.0000	$0	
Annual Costs	1	$79,900	0.9728	$77,724	
Annual Costs	2	$79,900	0.9463	$75,607	
Annual Costs	3	$79,900	0.9205	$73,547	
Annual Costs	4	$79,900	0.8954	$71,544	
Annual Costs	5	$79,900	0.8710	$69,596	
5-Year Costs	5	$5,000	0.8710	$4,355	
Annual Costs	6	$79,900	0.8473	$67,700	
Annual Costs	7	$79,900	0.8242	$65,856	
Annual Costs	8	$79,900	0.8018	$64,062	
Annual Costs	9	$79,900	0.7799	$62,317	
Annual Costs	10	$79,900	0.7587	$60,620	
5-Year Costs	10	$5,000	0.7587	$3,793	
Annual Costs	11	$79,900	0.7380	$58,969	
Annual Costs	12	$79,900	0.7179	$57,363	
Annual Costs	13	$79,900	0.6984	$55,800	
Annual Costs	14	$79,900	0.6794	$54,280	
Annual Costs	15	$79,900	0.6609	$52,802	
5-Year Costs	15	$5,000	0.6609	$3,304	
Annual Costs	16	$79,900	0.6429	$51,364	
Annual Costs	17	$79,900	0.6253	$49,965	
Annual Costs	18	$79,900	0.6083	$48,604	
Annual Costs	19	$79,900	0.5917	$47,280	
Annual Costs	20	$79,900	0.5756	$45,992	
5-Year Costs	20	$5,000	0.5756	$2,878	
Annual Costs	21	$79,900	0.5599	$44,740	
Annual Costs	22	$79,900	0.5447	$43,521	
Annual Costs	23	$79,900	0.5299	$42,336	
Annual Costs	24	$79,900	0.5154	$41,182	
5-Year Costs	25	$5,000	0.5014	$2,507	
Annual Costs	26	$79,900	0.4877	$38,970	
Annual Costs	27	$79,900	0.4744	$37,908	
Annual Costs	28	$79,900	0.4615	$36,876	
Annual Costs	29	$79,900	0.4490	$35,871	
5-Year Review Report and IC Maintenance	30	$5,000	0.4367	$2,184	
		$2,267,200		$1,551,416	

TOTAL COST OF ALTERNATIVE	**$2,267,000**
TOTAL PRESENT WORTH OF ALTERNATIVE	**$1,551,000**
PROJECT DURATION	**30 Years**

Prepared/Date: KPW 11/01/2019
Checked/Date: APP 12/09/2019

Table 4.5-2
Cost Estimate for Alternative SW 3

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

NOTES

This alternative (SW 3) includes installation of a series of groundwater extraction wells at locations upgradient (west and northwest) of the weir at the upstream location of South Ditch, and one groundwater extraction well midway along South Ditch between the weir and discharge location where the South Ditch meets the East Ditch. The alternative also includes a series of groundwater extraction wells along East Ditch from just south of Plant B downstream to just south of the confluence with South Ditch and the Ephemeral Drainage. Extracted groundwater would be conveyed to the treatment plant proposed to be constructed as part of the groundwater remediation alternatives. The treated groundwater would then be discharged to surface drainage; some discharged to the northern portion of East Ditch and some being discharged to the upstream portion of South Ditch. The groundwater extraction and treatment system is assumed to operate for 30 years.

Base Year (Year 0) = 2019

CAPITAL COSTS

Description	Quantity	Units	Unit Cost	Extended Cost	Note
Pre-Design Investigations	1	LS	$50,000	$50,000	Based on Similar Projects
Remedial Design	1	LS	$30,000	$30,000	Based on Similar Projects
Extraction System Installation					
Mobilization / Demobilization	1	LS	$50,000	$50,000	Based on Similar Projects
Extraction Well Drilling/Construction - East Ditch	17	EA	$60,000	$1,020,000	Estimate from Environmental Remediation Contractor
Pump Enclosure Vaults - East Ditch	17	EA	$13,500	$229,500	Estimate from Environmental Remediation Contractor
Pump, Controls, and Enclosure Piping - East Ditch	17	EA	$31,000	$527,000	Estimate from Environmental Remediation Contractor
Extraction Well Drilling/Construction - South Ditch	4	EA	$60,000	$240,000	Estimate from Environmental Remediation Contractor
Pump Enclosure Vaults - South Ditch	4	EA	$13,500	$54,000	Estimate from Environmental Remediation Contractor
Pump, Controls, and Enclosure Piping - South Ditch	4	EA	$31,000	$124,000	Estimate from Environmental Remediation Contractor
Conveyance Piping to GW Treatment System	3640	LF	$215	$782,600	Estimate from Environmental Remediation Contractor
Power Drop and Electrical Connections	2	EA	$250,000	$500,000	Estimate from Environmental Remediation Contractor
Oversight During Well & System Installation	120	Days	$1,000	$120,000	Oversight for 6 months
Remedial Action Report	1	LS	$10,000	$10,000	Based on Similar Projects
Contingency	1	LS	20%	$721,420	Based on Similar Projects
		TOTAL CAPITAL COSTS		$4,458,520	

ANNUAL COSTS

Description	Quantity	Units	Unit Cost	Extended Cost	Note
Electricity	1	LS	$17,200	$17,200	Groundwater treatment plant cost scaled for this flow rate
O&M Labor	1040	Labor Hours	$100	$104,000	20 hours per week O&M
Annual Extraction Well Monitoring	1	LS	$28,900	$28,900	Based on Similar Efforts - 21 extraction wells
Semi-Annual Groundwater and Surface Water Monitoring	2	Events	$20,850	$41,700	Based on Similar Efforts - 19 sampling locations
Monitoring/Performance Report	1	LS	$15,000	$15,000	Based on Similar Projects
		TOTAL ANNUAL COSTS		$206,800	

5-YEAR PERIODIC COSTS

Description	Quantity	Units	Unit Cost	Extended Cost	Note
Extraction Well O&M	21	EA	$2,000	$42,000	Based on Similar Projects
5-Year Review Report	1	LS	$5,000	$5,000	Incremental Costs Only - Will be performed site-wide
Deed Restrictions Verification and Maintenance	0	LS	$5,000	$0	N/A - Performed Internally to Olin
	TOTAL 5-YEAR PERIODIC COSTS			$47,000	

Table 4.5-2
Cost Estimate for Alternative SW 3

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

PRESENT VALUE ANALYSIS					
Cost Type	**Year**	**Total Cost**	**Discount Factor**	**Present Value**	**Note**
Capital Costs	0	$4,458,520	1.0000	$4,458,520	
Annual Costs	1	$206,800	0.9728	$201,167	
Annual Costs	2	$206,800	0.9463	$195,688	
Annual Costs	3	$206,800	0.9205	$190,358	
Annual Costs	4	$206,800	0.8954	$185,173	
Annual Costs	5	$206,800	0.8710	$180,130	
5-Year Costs	5	$47,000	0.8710	$40,939	
Annual Costs	6	$206,800	0.8473	$175,223	
Annual Costs	7	$206,800	0.8242	$170,451	
Annual Costs	8	$206,800	0.8018	$165,808	
Annual Costs	9	$206,800	0.7799	$161,292	
Annual Costs	10	$206,800	0.7587	$156,899	
5-Year Costs	10	$47,000	0.7587	$35,659	
Annual Costs	11	$206,800	0.7380	$152,625	
Annual Costs	12	$206,800	0.7179	$148,468	
Annual Costs	13	$206,800	0.6984	$144,424	
Annual Costs	14	$206,800	0.6794	$140,490	
Annual Costs	15	$206,800	0.6609	$136,664	
5-Year Costs	15	$47,000	0.6609	$31,060	
Annual Costs	16	$206,800	0.6429	$132,942	
Annual Costs	17	$206,800	0.6253	$129,321	
Annual Costs	18	$206,800	0.6083	$125,798	
Annual Costs	19	$206,800	0.5917	$122,372	
Annual Costs	20	$206,800	0.5756	$119,039	
5-Year Costs	20	$47,000	0.5756	$27,054	
Annual Costs	21	$206,800	0.5599	$115,796	
Annual Costs	22	$206,800	0.5447	$112,642	
Annual Costs	23	$206,800	0.5299	$109,574	
Annual Costs	24	$206,800	0.5154	$106,590	
Annual Costs	25	$206,800	0.5014	$103,687	
5-Year Costs	25	$47,000	0.5014	$23,565	
Annual Costs	26	$206,800	0.4877	$100,862	
Annual Costs	27	$206,800	0.4744	$98,115	
Annual Costs	28	$206,800	0.4615	$95,443	
Annual Costs	29	$206,800	0.4490	$92,843	
Annual Costs	30	$206,800	0.4367	$90,314	
5-Year Review Report and IC Maintenance	30	$47,000	0.4367	$20,526	
		$10,944,520		$8,797,522	
		TOTAL COST OF ALTERNATIVE	**$10,945,000**		
		TOTAL PRESENT WORTH OF ALTERNATIVE	**$8,798,000**		
		PROJECT DURATION	**30 Years**		

Prepared/Date: KPW 10/30/2019
Checked/Date: APP 12/09/2019

Table 4.5-3
Cost Estimate for Alternative SW 4

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

NOTES

This alternative (SW 4) includes installation of a series of groundwater extraction wells at locations upgradient (west and northwest) of the weir at the upstream location of South Ditch, and one groundwater extraction well midway along South Ditch between the weir and discharge location where the South Ditch meets the East Ditch.
Extracted groundwater would be conveyed to the treatment plant proposed to be constructed as part of the groundwater remediation alternatives. The treated groundwater would then be discharged to the upstream portion of South Ditch. The groundwater extraction and treatment system is assumed to operate for 30 years.

Base Year (Year 0) = 2019

CAPITAL COSTS

Description	Quantity	Units	Unit Cost	Extended Cost	Note
Pre-design Investigations	1	LS	$25,000	$25,000	Based on Similar Projects
Remedial Design	1	LS	$20,000	$20,000	Based on Similar Projects
Extraction System Installation					
Mobilization / Demobilization	1	LS	$20,000	$20,000	Based on Similar Projects
Extraction Well Drilling/Construction - South Ditch	4	EA	$60,000	$240,000	Estimate from Environmental Remediation Contractor
Pump Enclosure Vaults - South Ditch	4	EA	$13,500	$54,000	Estimate from Environmental Remediation Contractor
Pump, Controls, and Enclosure Piping - South Ditch	4	EA	$31,000	$124,000	Estimate from Environmental Remediation Contractor
Conveyance Piping to GW Treatment System	2420	LF	$215	$520,300	Estimate from Environmental Remediation Contractor
Power Drop and Electrical Connections	1	EA	$250,000	$250,000	Estimate from Environmental Remediation Contractor
Oversight During Well & System Installation	60	Days	$1,000	$60,000	Oversight for 3 months
Remedial Action Report	1	LS	$10,000	$10,000	Based on Similar Projects
Contingency	1	LS	20%	$250,660	Based on Similar Projects
		TOTAL CAPITAL COSTS		$1,573,960	

ANNUAL COSTS

Description	Quantity	Units	Unit Cost	Extended Cost	Note
Electricity	1	LS	$1,900	$1,900	Groundwater treatment plant cost scaled for this flow rate
O&M Labor	1040	Labor Hours	$100	$104,000	20 hours per week O&M
Annual Extraction Well Monitoring	1	LS	$6,100	$6,100	Based on Similar Efforts - 4 extraction wells
Semi-Annual Groundwater and Surface Water Monitoring	2	Events	$20,850	$41,700	Based on Similar Efforts - 19 sampling locations
Monitoring/Performance Report	1	LS	$15,000	$15,000	Based on Similar Projects
		TOTAL ANNUAL COSTS		$168,700	

5-YEAR PERIODIC COSTS

Description	Quantity	Units	Unit Cost	Extended Cost	Note
Extraction Well O&M	4	EA	$2,000	$8,000	Based on Similar Projects
5-Year Review Report	1	LS	$5,000	$5,000	Incremental Costs Only - Will be performed site-wide
Deed Restrictions Verification and Maintenance	0	LS	$5,000	$0	N/A - Performed Internally to Olin
	TOTAL 5-YEAR PERIODIC COSTS			$13,000	

Table 4.5-3
Cost Estimate for Alternative SW 4

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

PRESENT VALUE ANALYSIS					
Cost Type	**Year**	**Total Cost**	**Discount Factor**	**Present Value**	**Note**
Capital Costs	0	$1,573,960	1.0000	$1,573,960	
Annual Costs	1	$168,700	0.9728	$164,105	
Annual Costs	2	$168,700	0.9463	$159,635	
Annual Costs	3	$168,700	0.9205	$155,287	
Annual Costs	4	$168,700	0.8954	$151,058	
Annual Costs	5	$168,700	0.8710	$146,943	
5-Year Costs	5	$13,000	0.8710	$11,323	
Annual Costs	6	$168,700	0.8473	$142,941	
Annual Costs	7	$168,700	0.8242	$139,048	
Annual Costs	8	$168,700	0.8018	$135,260	
Annual Costs	9	$168,700	0.7799	$131,576	
Annual Costs	10	$168,700	0.7587	$127,992	
5-Year Costs	10	$13,000	0.7587	$9,863	
Annual Costs	11	$168,700	0.7380	$124,506	
Annual Costs	12	$168,700	0.7179	$121,115	
Annual Costs	13	$168,700	0.6984	$117,816	
Annual Costs	14	$168,700	0.6794	$114,607	
Annual Costs	15	$168,700	0.6609	$111,485	
5-Year Costs	15	$13,000	0.6609	$8,591	
Annual Costs	16	$168,700	0.6429	$108,449	
Annual Costs	17	$168,700	0.6253	$105,495	
Annual Costs	18	$168,700	0.6083	$102,622	
Annual Costs	19	$168,700	0.5917	$99,827	
Annual Costs	20	$168,700	0.5756	$97,108	
5-Year Costs	20	$13,000	0.5756	$7,483	
Annual Costs	21	$168,700	0.5599	$94,463	
Annual Costs	22	$168,700	0.5447	$91,890	
Annual Costs	23	$168,700	0.5299	$89,387	
Annual Costs	24	$168,700	0.5154	$86,952	
Annual Costs	25	$168,700	0.5014	$84,584	
5-Year Costs	25	$13,000	0.5014	$6,518	
Annual Costs	26	$168,700	0.4877	$82,280	
Annual Costs	27	$168,700	0.4744	$80,039	
Annual Costs	28	$168,700	0.4615	$77,859	
Annual Costs	29	$168,700	0.4490	$75,738	
Annual Costs	30	$168,700	0.4367	$73,675	
5-Year Review Report and IC Maintenance	30	$13,000	0.4367	$5,677	
		$6,712,960		$5,017,157	
		TOTAL COST OF ALTERNATIVE	**$6,713,000**		
		TOTAL PRESENT WORTH OF ALTERNATIVE	**$5,017,000**		
		PROJECT DURATION	**30 Years**		

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Table 4.5-4
Cost Estimate for Alternative SW 5

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

NOTES

This alternative (SW 5) consists of installation of a PRB along the length of South Ditch and along the west side of East Ditch from just south of Plant B downstream to just south of the confluence with South Ditch and the Ephemeral Drainage. Installation of the PRB and sheet pile wall is estimated to take approximately 4 months, followed by 30 years of post-remediation monitoring, and five-year reviews. The alternative assumes full media replacement every 20 years.

Base Year (Year 0) = 2019

CAPITAL COSTS

Description	Quantity	Units	Unit Cost	Extended Cost	Note
Pre-Design Investigations					
Mobilization/Demobilization	1	LS	$2,000	$2,000	Based on Similar Projects
Driller and Rig	8	days	$2,000	$16,000	Based on Similar Projects
Oversight	8	days	$1,000	$8,000	Based on Similar Projects
Treatability Testing	1	LS	$5,000	$5,000	Based on Similar Projects
Geotech Evaluation	1	LS	$10,000	$10,000	Based on Similar Projects
Remedial Design	1	LS	$50,000	$50,000	Based on Similar Projects
PRB Installation					
Mobilization/Demobilization	1	LS	$95,920	$95,920	Estimate from Environmental Remediation Contractor
Installation Oversight for 4 Months	80	days	$1,000	$80,000	Based on Similar Projects
Erosion Control	1	LS	$13,399	$13,399	Estimate from Environmental Remediation Contractor
PRB Installation (2,340 Linear Feet, 50/50 Zeolite/GAC)	1	LS	$11,204,187	$11,204,187	Estimate from Environmental Remediation Contractor
Grouted Sheet Pile Wall Installation (415 Linear Feet)	1	LS	$258,900	$258,900	Estimate from Environmental Remediation Contractor
Transportation and Disposal of Excvated Soil (Non-hazardous)	5800	Tons	$90.16	$522,928	Estimate from Environmental Remediation Contractor
Remedial Action Report	1	LS	$10,000	$10,000	Based on Similar Projects
Contingency	1	LS	20%	$2,455,267	Based on Similar Projects
		TOTAL CAPITAL COSTS		$14,731,601	

ANNUAL COSTS

Description	Quantity	Units	Unit Cost	Extended Cost	Note
Semi-Annual Groundwater and Surface Water Monitoring	2	Events	$20,850	$41,700	Based on Similar Efforts - 19 sampling locations
Monitoring/Performance Report	1	LS	$10,000	$10,000	Based on Similar Projects
		TOTAL ANNUAL COSTS		$51,700	

20-YEAR PERIODIC COSTS (OM&M)

Description	Quantity	Units	Unit Cost	Extended Cost	Note
PRB Media Replacement	1	LS	$11,300,107	$11,300,107	Assume full media replacement every 20 years
PRB Media Transportation and Disposal (Non-hazardous)	1	LS	$400,000	$400,000	Assume 4,000 tons of media for off-site disposal
	TOTAL 20-YEAR PERIODIC COSTS			$11,700,107	

5-YEAR PERIODIC COSTS

Description	Quantity	Units	Unit Cost	Extended Cost	Note
5-Year Review Report	1	LS	$5,000	$5,000	Incremental Costs Only - Will be performed site-wide
Deed Restrictions Verification and Maintenance	0	LS	$5,000	$0	N/A - Performed Internally to Olin
	TOTAL 5-YEAR PERIODIC COSTS			$5,000	

Table 4.5-4
Cost Estimate for Alternative SW 5

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

PRESENT VALUE ANALYSIS					
Cost Type	**Year**	**Total Cost**	**Discount Factor**	**Present Value**	**Note**
Capital Costs	0	$14,731,601	1.0000	$14,731,601	
Annual Costs	1	$51,700	0.9728	$50,292	
Annual Costs	2	$51,700	0.9463	$48,922	
Annual Costs	3	$51,700	0.9205	$47,590	
Annual Costs	4	$51,700	0.8954	$46,293	
Annual Costs	5	$51,700	0.8710	$45,032	
5-Year Costs	5	$5,000	0.8710	$4,355	
Annual Costs	6	$51,700	0.8473	$43,806	
Annual Costs	7	$51,700	0.8242	$42,613	
Annual Costs	8	$51,700	0.8018	$41,452	
Annual Costs	9	$51,700	0.7799	$40,323	
Annual Costs	10	$51,700	0.7587	$39,225	
5-Year Costs	10	$5,000	0.7587	$3,793	
Annual Costs	11	$51,700	0.7380	$38,156	
Annual Costs	12	$51,700	0.7179	$37,117	
Annual Costs	13	$51,700	0.6984	$36,106	
Annual Costs	14	$51,700	0.6794	$35,123	
Annual Costs	15	$51,700	0.6609	$34,166	
5-Year Costs	15	$5,000	0.6609	$3,304	
Annual Costs	16	$51,700	0.6429	$33,235	
Annual Costs	17	$51,700	0.6253	$32,330	
Annual Costs	18	$51,700	0.6083	$31,450	
Annual Costs	19	$51,700	0.5917	$30,593	
Annual Costs	20	$51,700	0.5756	$29,760	
20-Year Costs	20	$11,700,107	0.5756	$6,734,844	
5-Year Costs	20	$5,000	0.5756	$2,878	
Annual Costs	21	$51,700	0.5599	$28,949	
Annual Costs	22	$51,700	0.5447	$28,161	
Annual Costs	23	$51,700	0.5299	$27,394	
Annual Costs	24	$51,700	0.5154	$26,647	
Annual Costs	25	$51,700	0.5014	$25,922	
5-Year Costs	25	$5,000	0.5014	$2,507	
Annual Costs	26	$51,700	0.4877	$25,216	
Annual Costs	27	$51,700	0.4744	$24,529	
Annual Costs	28	$51,700	0.4615	$23,861	
Annual Costs	29	$51,700	0.4490	$23,211	
Annual Costs	30	$51,700	0.4367	$22,579	
5-Year Review Report and IC Maintenance	30	$5,000	0.4367	$2,184	
		$28,012,708		$22,525,516	
		TOTAL COST OF ALTERNATIVE	**$28,013,000**		
		TOTAL PRESENT WORTH OF ALTERNATIVE	**$22,526,000**		
		PROJECT DURATION	**30 Years**		

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Table 4.5-5
Cost Estimate for Alternative SW 6

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

NOTES

This alternative (SW 6) would include construction of a PRB perpendicular to the direction of groundwater flow in the vicinity of the weir and at a location in the upstream portion of South Ditch where contaminated groundwater flows laterally to and discharges to the ditch. Reactive materials for the PRB would consist of zeolites to treat ammonia and activated carbon to treat chromium. The PRB would be installed to the weathered bedrock surface and extend to just below ground surface. Installation of the PRB is estimated to take approximately 2 months, followed by 30 years of post-remediation monitoring, and five-year reviews. The alternative assumes full media replacement every 20 years.

Base Year (Year 0) = 2019

CAPITAL COSTS

Description	Quantity	Units	Unit Cost	Extended Cost	Note
Pre-Design Investigations					
Mobilization/Demobilization	1	LS	$2,000	$2,000	Based on Similar Projects
Driller and Rig	2	days	$2,000	$4,000	Based on Similar Projects
Oversight	2	days	$1,000	$2,000	Based on Similar Projects
Treatability Testing	1	LS	$5,000	$5,000	Based on Similar Projects
Geotech Evaluation	1	LS	$10,000	$10,000	Based on Similar Projects
Remedial Design	1	LS	$50,000	$50,000	Based on Similar Projects
PRB Installation					
Mobilization/Demobilization	1	LS	$95,920	$95,920	Estimate from Environmental Remediation Contractor
Installation Oversight for 2 Months	40	days	$1,000	$40,000	Based on Similar Projects
Erosion Control	1	LS	$13,399	$13,399	Estimate from Environmental Remediation Contractor
PRB Installation (600 Linear Feet, 50/50 Zeolite/GAC)	1	LS	$2,732,171	$2,732,171	Estimate from Environmental Remediation Contractor
Grouted Sheet Pile Wall Installation (115 Linear Feet)	1	LS	$74,340	$74,340	Estimate from Environmental Remediation Contractor
Transportation and Disposal of Excvated Soil (Non-hazardous)	860	Tons	$90.16	$77,538	Estimate from Environmental Remediation Contractor
Remedial Action Report	1	LS	$10,000	$10,000	Based on Similar Projects
Contingency	1	LS	20%	$605,766	Based on Similar Projects
		TOTAL CAPITAL COSTS		$3,722,134	

ANNUAL COSTS

Description	Quantity	Units	Unit Cost	Extended Cost	Note
Semi-Annual Groundwater and Surface Water Monitoring	2	Events	$20,850	$41,700	Based on Similar Efforts - 19 sampling locations
Monitoring/Performance Report	1	LS	$10,000	$10,000	Based on Similar Projects
		TOTAL ANNUAL COSTS		$51,700	

20-YEAR PERIODIC COSTS (OM&M)

Description	Quantity	Units	Unit Cost	Extended Cost	Note
PRB Media Replacement	1	LS	$2,828,091	$2,828,091	Assume full media replacement every 20 years
PRB Media Transportation and Disposal (Non-hazardous)	1	LS	$115,000	$115,000	Assume 1,150 tons of media for off-site disposal
	TOTAL 20-YEAR PERIODIC COSTS			$2,943,091	

5-YEAR PERIODIC COSTS

Description	Quantity	Units	Unit Cost	Extended Cost	Note
5-Year Review Report	1	LS	$5,000	$5,000	Incremental Costs Only - Will be performed site-wide
Deed Restrictions Verification and Maintenance	0	LS	$5,000	$0	N/A - Performed Internally to Olin
	TOTAL 5-YEAR PERIODIC COSTS			$5,000	

Table 4.5-5
Cost Estimate for Alternative SW 6

Operable Unit 1 and Operable Unit 2 Feasibility Study
Olin Chemical Superfund Site
Wilmington, Massachusetts

PRESENT VALUE ANALYSIS					
Cost Type	**Year**	**Total Cost**	**Discount Factor**	**Present Value**	**Note**
Capital Costs	0	$3,722,134	1.0000	$3,722,134	
Annual Costs	1	$51,700	0.9728	$50,292	
Annual Costs	2	$51,700	0.9463	$48,922	
Annual Costs	3	$51,700	0.9205	$47,590	
Annual Costs	4	$51,700	0.8954	$46,293	
Annual Costs	5	$51,700	0.8710	$45,032	
5-Year Review Report and IC Maintenance	5	$5,000	0.8710	$4,355	
Annual Costs	6	$51,700	0.8473	$43,806	
Annual Costs	7	$51,700	0.8242	$42,613	
Annual Costs	8	$51,700	0.8018	$41,452	
Annual Costs	9	$51,700	0.7799	$40,323	
Annual Costs	10	$51,700	0.7587	$39,225	
5-Year Costs	10	$5,000	0.7587	$3,793	
Annual Costs	11	$51,700	0.7380	$38,156	
Annual Costs	12	$51,700	0.7179	$37,117	
Annual Costs	13	$51,700	0.6984	$36,106	
Annual Costs	14	$51,700	0.6794	$35,123	
Annual Costs	15	$51,700	0.6609	$34,166	
5-Year Costs	15	$5,000	0.6609	$3,304	
Annual Costs	16	$51,700	0.6429	$33,235	
Annual Costs	17	$51,700	0.6253	$32,330	
Annual Costs	18	$51,700	0.6083	$31,450	
Annual Costs	19	$51,700	0.5917	$30,593	
Annual Costs	20	$51,700	0.5756	$29,760	
20-Year Cocts	20	$2,943,091	0.5756	$1,694,109	
5-Year Costs	20	$5,000	0.5756	$2,878	
Annual Costs	21	$51,700	0.5599	$28,949	
Annual Costs	22	$51,700	0.5447	$28,161	
Annual Costs	23	$51,700	0.5299	$27,394	
Annual Costs	24	$51,700	0.5154	$26,647	
Annual Costs	25	$51,700	0.5014	$25,922	
5-Year Costs	25	$5,000	0.5014	$2,507	
Annual Costs	26	$51,700	0.4877	$25,216	
Annual Costs	27	$51,700	0.4744	$24,529	
Annual Costs	28	$51,700	0.4615	$23,861	
Annual Costs	29	$51,700	0.4490	$23,211	
Annual Costs	30	$51,700	0.4367	$22,579	
5-Year Review Report and IC Maintenance	30	$5,000	0.4367	$2,184	
		$8,246,225		$6,475,314	
		TOTAL COST OF ALTERNATIVE	**$8,246,000**		
		TOTAL PRESENT WORTH OF ALTERNATIVE	**$6,475,000**		
		PROJECT DURATION	**30 Years**		

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